R-4088-A

Nikon

STEREOSCOPIC MICROSCOPE

SMZ-10

REPAIR MANUAL

Forward:

This manual purposes to serve beginners as well as experts in carrying out the repair in general of the stereoscopic microscope SMZ-10.

If the impairment is beyond the scope of this manual, the repair is to be submitted to our Service Dept.

NIPPON KOGAKU K.K.

INSTRUMENTS DIVISION

S 53.8.15

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PREPARATION FOR REPAIR

- Keep lenses from dust, finger mark, etc. which may cause rust or deterioration of lens surfaces if they are left as they are for a long time.

  To clean a lens, remove dust by a soft brush and wipe with clean soft washed cotton cloth lightly.

  Remove finger marks or oily soil using soft clean cotton cloth, lens tissue or gauze moistened slightly with alcohol (methanol or ethanol).
- Avoid using organic solvent (such as thinner, xylene, ether, alcohol, etc.) in cleaning painted surfaces or plastic parts.
- Use the specified tools only for repair excepting emergency.
- Please be acquainted with the principle of optics and mechanism of the microscope in advance because it is delicately constructed and adjusted.
- Use this manual in reference with the Repair parts list R-6118.A and R-6119.A
- For inquiring spare parts, please confirm the parts No. by the parts list as the parts No. might be changed in course of modification, etc.

TOOLS AND SUPPLIES

1. Tools for General Use

Item	Used for
(–) 6 screwdriver set	Standard screws
(+) 4 screwdriver set	"
(–) Screwdriver (4 – 6 mm)	"
(+) Screwdriver (4 – 6 mm)	"
Tweezers (stainless steel)	General use.
Hexagonal wrench	Hexagonal socket screws.
Blower	Lens cleaning.
Injector	Lubrication
Handlap	Keeping alcohol for cleaning.

2. Special Tools

Item	Used for
Spring hooker (Fig. 45)	Placing and displacing spring (27) on hook (25).
Level	Checking horizontal of parallel stereo tool and parallel collimators.
Diopter telescope (Fig. 28)	Repair and adjustment in general
Parallel stereo tool J25116 (with special collimator) (Fig. 18)	Adjusting mechanical axis, revolving and optical axis of erecting prism (G4, 5, 6) photographic tube, parfocal zooming and diopter perpendicularity and parallelism of optical axes
Parallel collimators (Fig. 18)	Adjusting mechanical axis, revolving axis and optical axis of erecting prism, photographic tube.
10X Kellner reticle eyepiece	" "
Inclining prism tool J25114 (Fig. 19)	Adjusting revolving axis and optical axis of erecting prism.
Erecting prism tool J25115 (Fig. 19)	Adjusting revolving axis and optical axis of erecting prism.
15X eyepiece with diopter scale.	Adjusting parfocal diopter, perpendicularity and parallelism of optical axis
Measuring eyepiece for parfocal zooming J25117 (Fig. 53)	Adjusting perpendicularity and parallelism of optical axis.

3. Lubricant

Item	Used for
G7910	(Body)(1)Casting w/bayonet –(15)Zooming cam; (Trinocular tube)(2)Photo lens holder –(9)Path change over axis tube, (23) Change-over grooved plate.
G7920	(Body)(15) Zooming cam surface (Trinocular tube)(24) Eyepiece sleeve holder –(28) Adjusting eyepiece sleeve; (1)Trinoculars body –(5)(6)Interpupillary distance adjustment, (35) Guide screw (36) Spring washer.
G6053	(Body)(1)Casting w/bayonet –(6)Connecting pin; (Trinocular tube) (13) Clamp screw.
G7811	(Body)(6)Connecting pin –(17) Lens carrier –(22) Sliding chip.

4. Adhesive

Item	Used for
#616	(Body) (18) Bearing holder –(19) Bearing shaft (18) –(91a) Screw. (Trinocular tube)(1)Body –(41) Light shielding pad, (8)Round dovetail mount –(17) Screw.
#350	(Body)(5)Zooming ring –(95A) Screw. (Trinocular tube) (103a) Screw.
KE24	(Trinocular tube) (94a) Fine adjusting screw

5. Other Supplies

Gasoline (for cleaning), Lens tissue, Gauze, Cotton cloth, Alcohol (methanol or ethanol), Brush, Tin-foil (for adjustment).

PRINCIPLE

The optical system of the parallel axes stereoscopic microscope consists of the optical elements as shown in Fig. 1.

The light ray propagating from the principal focus of the primary objective is refracted by the objective and goes out the objective in parallel with the optical axis.

By placing a couple of optical systems behind the objective in parallel with the principal axis, the stereoscopic viewing is made possible.

The parallel light flux coming out of the primary objective and entering the zooming lens group is refracted and goes out the zooming lens group again in parallel with the optical axis.

The parallel light flux from the zooming lens group enters into the secondary objective and focuses at its image side principal focus.

Between the secondary lens and its image side focus, the inclining and the erecting prisms are placed for convenience of the observation.

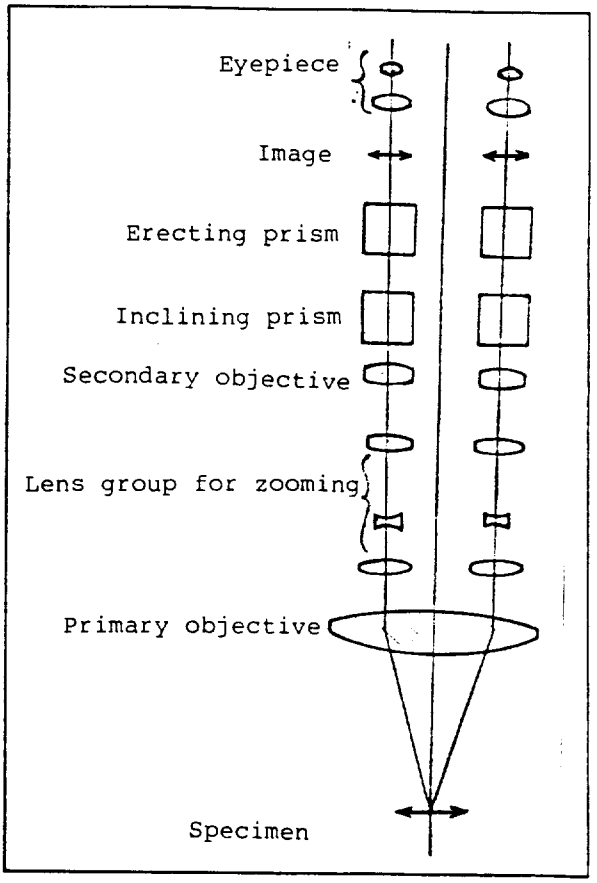

Fig. 1

The parallel light flux between the primary objective and the zooming lens group and the same between the zooming lens group and the secondary objective afford replacing the primary objective with another different objective or replacing the zooming lens group with another kind of magnification change over system such as a turret mounted lens group.

And the parallel light flux also afford replacing the eyepiece with another one with different inclination angle etc.

Further, the intermediate tube can be inserted between the secondary objective and the zooming lens group to attach the photographic equipment.

Therefore, the microscope can be built up by combining the objective unit, intermediate tube unit (zooming lens unit), the eyepiece tube unit and the eyepiece, being connected together by means of the bayonet mount or the screw mount and enabling interchangeable replacement with other unit of different feature.

Further, if necessary, a specific unit (for example, a drawing attachment) can be inserted between one unit (zooming unit) and another (eyepiece tube).

It is, however, important to note that each unit is to be made with sufficient accuracy to render efficient performance when combined together to constitute a complete stereoscopic microscope.

REPAIR AND ADJUSTMENT

- Before starting the repair, make sure where is the impairment and what is the cause of impairment:

  As the SMZ-10 is a parallel axes stereoscopic microscope consists of the trinoculars tube (or binoculars tube) unit and the zooming tube unit, the first thing to do when it fails to function and is to be repaired is to find out which unit is responsible to the failure.

  There may be a chance to put the microscope in order by repairing the zooming tube instead of the trinoculars tube although the optical axis or parfocal zooming were out of order because of a fault in the trinoculars tube.

  In such a case, however, the repair will not be assured of the accuracy when such a zooming tube would be combined with an other trinoculars tube etc.

  It is must, therefore to locate the impairment, and to make sure of its cause, then start the repair.

- Meaning of the mark (F), (P) used as remarks in Repair and adjustment procedure in this manual:

  (F) : Remarks useful to maintain specified feature of the microscope

  (P) : Remarks useful for ease and speed in practice of disassembling and assembling, etc.

- Troubles probable in usual cases and adequate measures for repair:

  (M) : Mechanical failure.

  (T) : Trinoculars tube is to be repaired.

  (Z) : Zooming tube is to be repaired.

Failure	Cause	Measure	Disassembling procedure	Adjusting procedure
1) Fatigue of eye in observation	Optical axis derangement of trinoculars (binoculars) tube.	• Adjust erecting prism (T). • Adjust inclining prism (T).	1) ~ 4), P.11 1) ~ 4), P.11	P. 16 P. 16
	Right and Left are not parfocal	• Recheck and adjust zooming lenses (Z). • Check diopter ring, secondary objective (T).	1) ~ 13) P. 27 ~ 29 1) ~ 14), P. 27 ~ 29	P. 32 P. 16
2) 4X and 0.66X not parfocal when binoculars diopter adjusted.	Inclining prism displacement of trinoculars (Binoculars) tube.	• Adjust inclining prism, because image not only deviates but also goes out of focus by zooming when the prism is displaced (T).	1) ~ 5) P. 11, 12	P. 16
	Zooming cam fails to function	• Remove rust by SUVET if guide rod (10) is rusted (Z), (M). • Exchange spring (26) (27) if they are yielded (Z), (M).	1) ~ 13) P. 27 ~ 29	P. 31 P. 29
	Failure of parfocal mechanism	• Adjust by procedure of accuracy adjustment.	1) ~ 13) P. 27 ~ 29	P. 32
3) **Magnification changes unintentionally during observation.**	Unintentional revolution of zooming ring.	• Fasten plate spring (40) to adjust zooming torque.	3) P. 27	P. 30
4) Optical axis deranges when interpupillary distance adjusted.	Erecting prism displaced.	• Adjust erecting prism of right or left eyepiece whichever image deviations is larger (T).	1) ~ 5) P. 11, 12	P. 16
	Binoculars sleeve bended by accidentally dropping trinoculars tube.	• Refer to adjusting mechanical axis (T).	1) ~ 14) P. 11 ~ 14	P. 15

Failure	Cause	Measure	Disassembling procedure	Adjusting procedure
5) Image deviates when magnification changed by zooming.	Binoculars sleeve bended by accidentally dropping trinoculars tube.	• Refer to adjusting mechanical axis (T).	1) ~ 14) P. 11 ~ 14	P. 15
	Derangement of erecting prism.	• Adjust optical axis by erecting prism.	1) ~ 5) P. 11, 12	P. 16
	Optical derangement of zooming tube.	• Recheck and adjust zooming lenses (Z).	1) ~ 13) P. 27 ~ 30	P. 32
6) Image deviates during zooming.	Sliding chip for guide rod loosened.	• Adjust sliding chip (22) to eliminate slack between chip and guide rod (10) (Z), (M)	1) ~ 13) P. 27 ~ 30	P. 29
	Dent or injury of zooming cam	• Exchange zooming cam (15) (Z), (M)	1) ~ 11) P. 27 ~ 29	P. 30
	Expansion of sliding guide on lens carrier (16) (17)	Exchange carrier	1) ~ 8) P. 27 ~ 28	P. 30
7) Unintentional change of interpupillary distance.	Slack in sliding of interpupillary distance adjustment.	• Adjust spring washer (36) (T) • Press to force celluloid washer (38) (T)	1) ~ 11) P. 27 ~ 29 1) ~ 8) P. 11, 12	P. 12
8) Failure in coupling of right and left prism boxes for interpupillary distance adjustment.	Damage of coupling gear	• Exchange coupling gear for interpupillary distance adjustment (30) (T), (M)	1) ~ 6) P. 11, 12	P. 12
9) Wrong indication for magnification.	Refer to 2).	Refer to 2).	1) ~ 5) P. 11, 12 1) ~ 13) P. 27 ~ 29	P. 16 P. 31

1. Trinoculars Tube (Binoculars Tube)

- The optical system of the trinoculars tube is so complicated that an adjustment of a lens or a prism may give influence over the total magnification optical axis, parfocal zooming etc. In repairing any part of the trinoculars tube, the function of other parts must be taken into consideration.

§ Function of optical elements

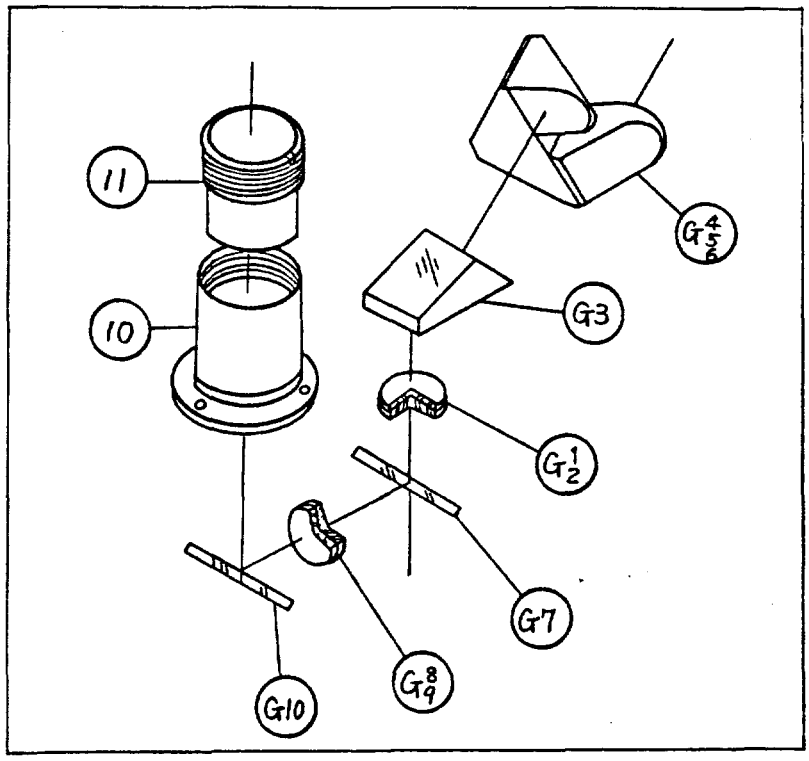

Fig. 2

(G4, 5, 6) Erecting prism : Adjusting the optical deflection due to deviation of revolving axis of the prism (Deranged position of this prism causes failure in the parallelism between the right and left optical axes and deviation of the zooming image).

(G3) Inclining prism: Adjusting the parallelism between the right and left optical axes (Deranged position of this prism causes failure in the parallelism between right and left optical axes, deviation of the zooming image, parfocal zooming and unevenness of the right and left eyepiece diopter).

(G1, 2) Secondary objective : Adjusting unevenness of the right and left eyepiece diopter. (Failure in positioning of this lens causes unevenness of the right and left eyepiece diopter and imperfect parfocal zooming).

(G7, 8, 9, 10) Photographic lens system:

The mirror (G7, 10) and the lens (G8, 9) are not to be used for adjusting the optical axis and parfocal zooming for which the straight tube (10)(11) are responsible.

Remarks : The binoculars tube does not have (G7, 8, 9, 10).

1–1. Disassembling

1) Releasing the set screws (104a) x3, take off the diopter ring (27-1) (Fig. 3).

2) Removing the guide screw (31), take out the eyepiece sleeve (28-1) (Fig. 4).

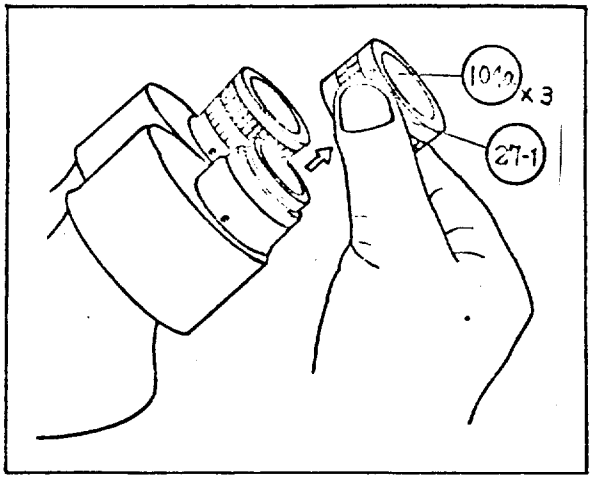

Fig. 3

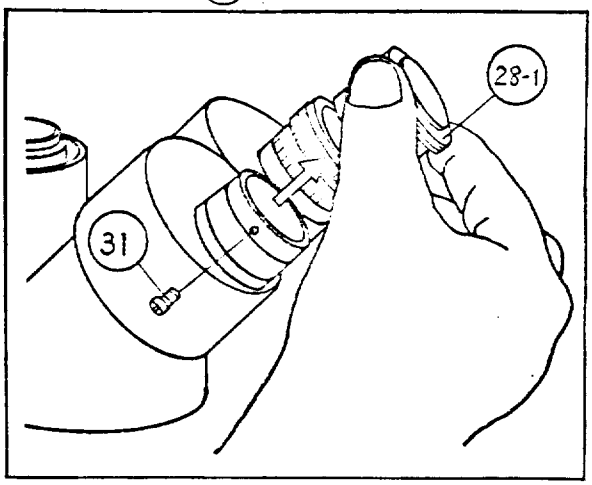

Fig. 4

Remarks: The microscopes manufactured by the production order No. 2 and thereafter do not require the procedure 2).

3) Releasing the set screws (104a) x3, take off the index ring (29-2) (Fig. 5).

4) Unscrewing the screws (109a) x2, remove the prism box (4-2) or (3-2) (Fig. 6).

Remarks: (P) The prism box (4-1) or (3-1) of the old type model are fixed by the screws located underside.

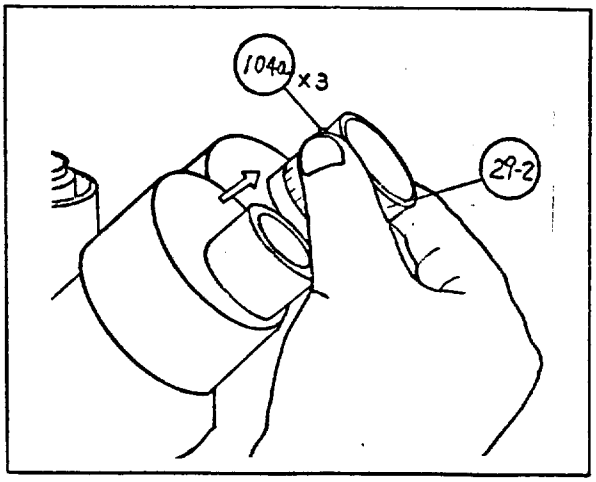

Fig. 5

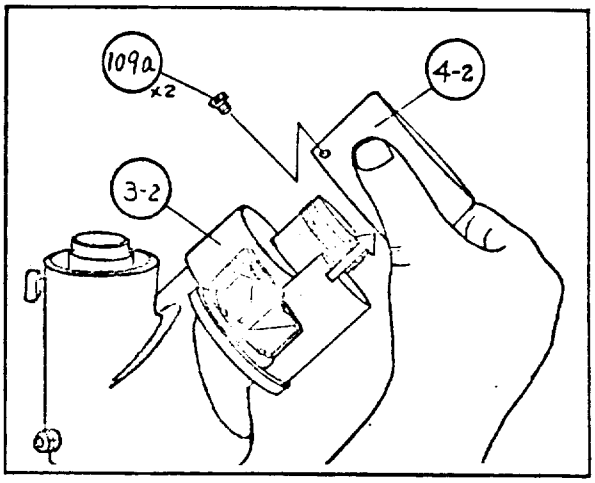

Fig. 6

5) Unscrewing the screws (101-b) x3, remove the prism seat (26) or (25) with the prism (Fig. 7).

(Apply alcohol to dissolve screwlock on (5-1), (6-1), (25), (26)).

6) Removing the screws (101e) x2 and notched washer (44), take off the interpupillary distance gear (30) (Fig. 8).

Remarks: (P) The newtype microscopes do not have the above gear.

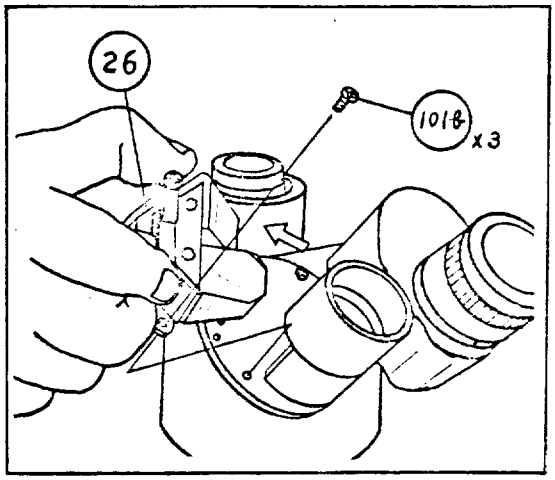

Fig. 7

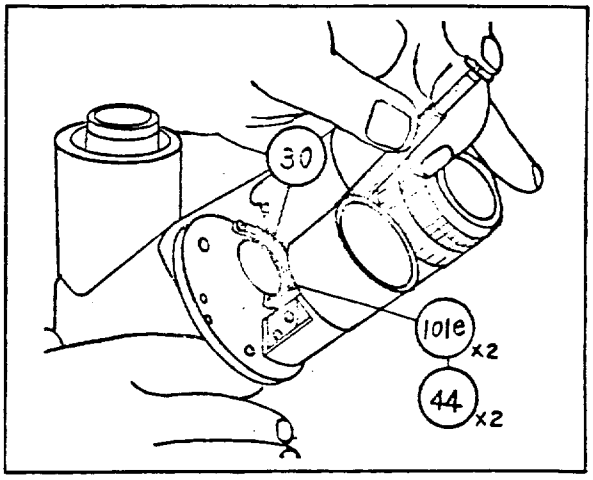

Fig. 8

7) Unscrewing the screws (101d) x2, remove the eyepiece sleeve holder (24-1) (Fig. 9).

8) Remove the screw (35) and the spring washer (36), take off the sleeve seat (6-2) (Fig. 10).

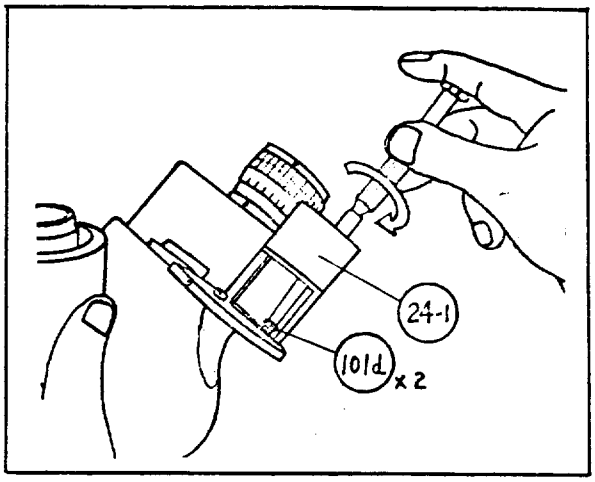

Fig. 9

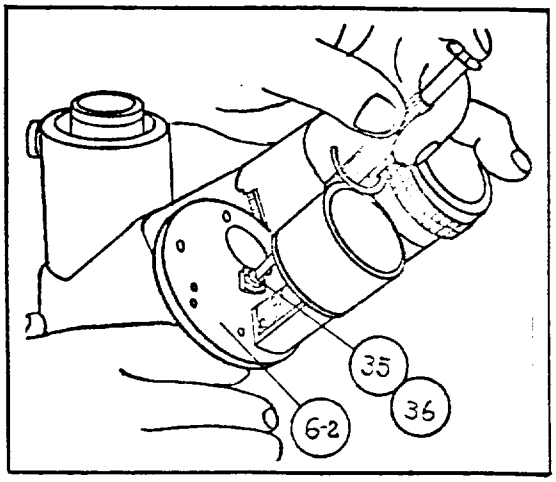

Fig. 10

8-1) For the microscopes manufactured by the production order No. 3 and thereafter, unscrew the screws (102d) x2 and remove the cover (47).

9) Removing the spring retainer (17), take out the spring (16) and the steel ball (15) (Fig. 11).

Remarks: (P) Take care of the spring flipping out.

10) Unscrewing the screws (101a) x3, remove the round dovetail mount (8-1) (Fig. 12).

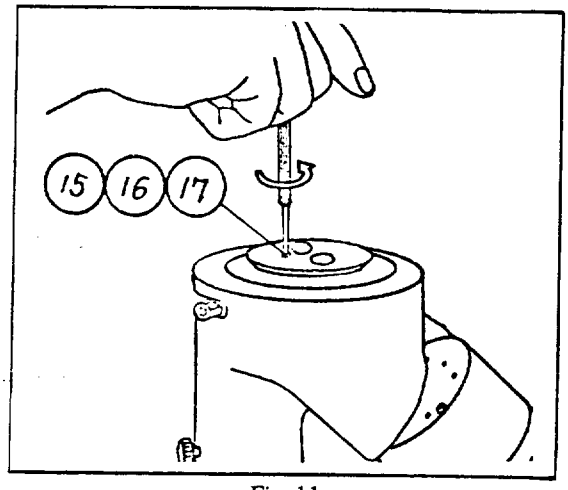

Fig. 11

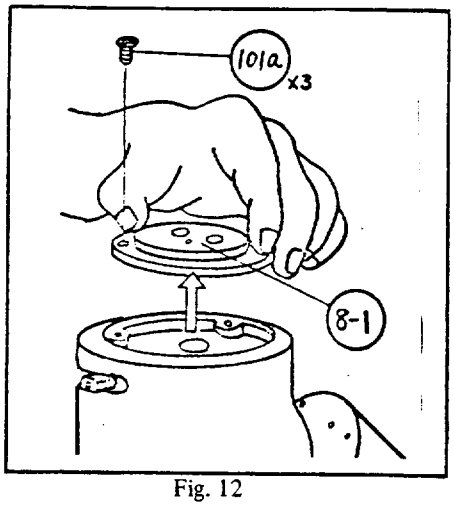

Fig. 12

11) Unscrewing the screws (101b) x2, take out the grooved plate (23). (Fig. 13, 14)

Remarks: (P) For ease of removing (23), set the switching over lever at middle.

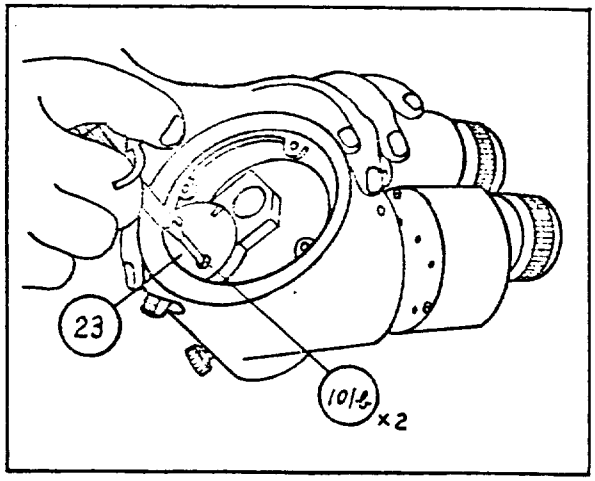

Fig. 13

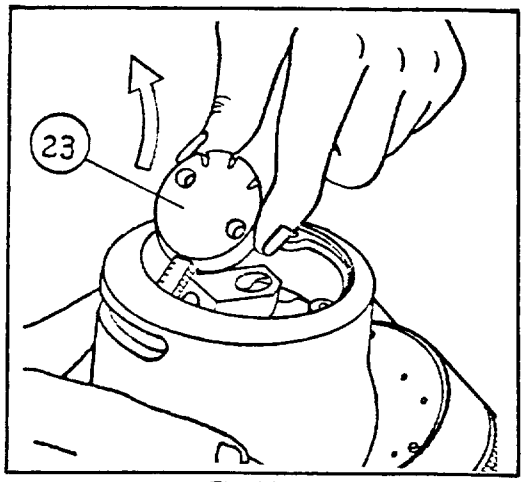

Fig. 14

12) Draw out the photographic lens holder (2) (Fig. 15).

13) Unscrewing the screws (101d)×3, remove the photoeyepiece sleeve receptacle (10) (Fig. 16).

Fig. 15

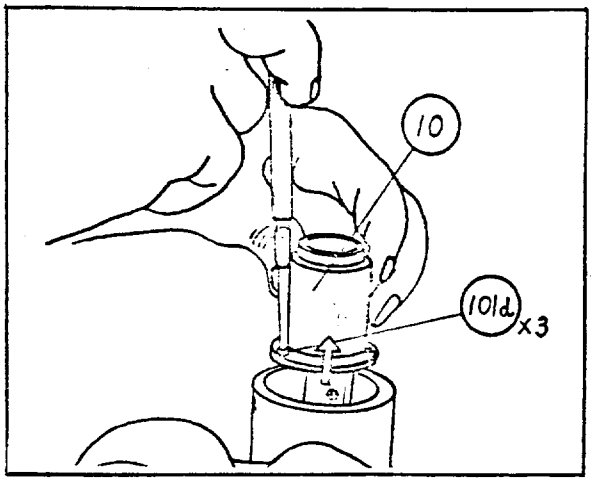

Fig. 16

14) Unscrewing the screws (102a)×2, remove the lens cell holder (7-1) with the lens and the prism (G1 ~ 3) (Fig. 17).

Remarks: (P), (F) Apply alcohol to dissolve screwlock on (1) and (7-1).

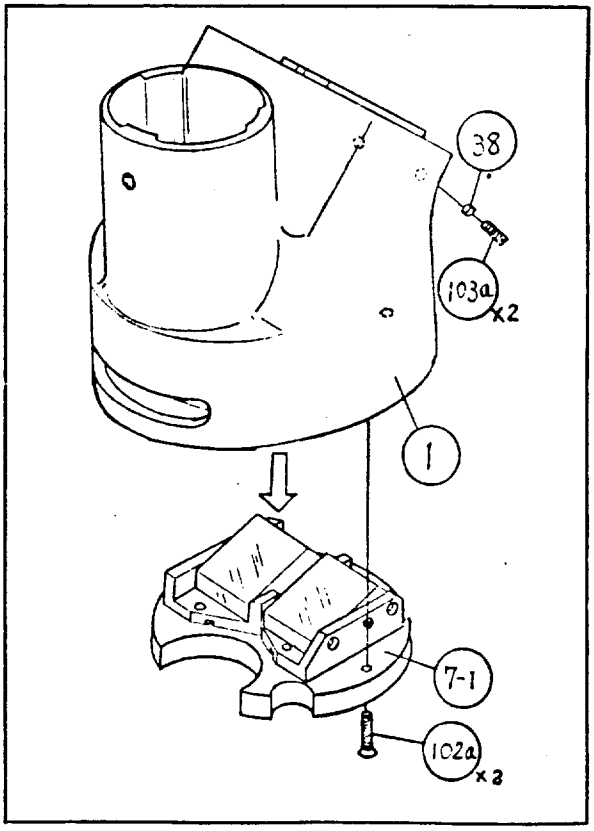

Fig. 17

1–2. Assembling

Proceed the assembling by reversing the disassembling procedure as 14) → 1), provided that the adjusting procedure is to be referred to.

1–3. Adjusting the mechanical axis

1) Inspection method

i) Place the microscope on the parallel stereo tool (J25116).

ii) Set the parallel collimators (A) on the tool assuring horizontal setting of the tool and the parallel collimators by using a level.

iii) Putting the crosshair eyepiece into the right side eyepiece sleeve and adjusting the parallel collimators stand, bring the collimator reticle image center to the eyepiece reticle center.

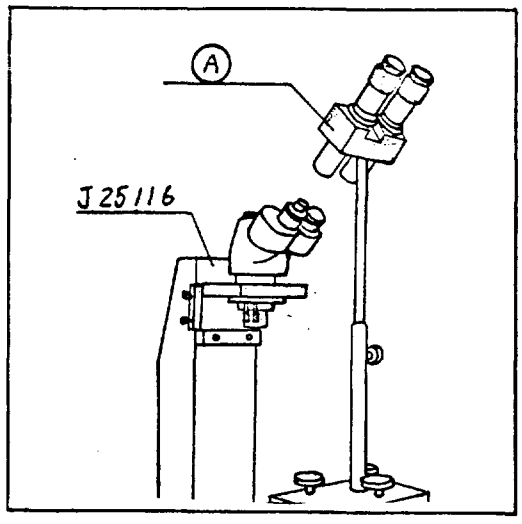

Fig. 18

iv) Replace the crosshair eyepiece from the right sleeve to the left sleeve and read the cross hair center deviation by the collimator scale.

(Inspection standard)

Parallelism between right and left eyepiece sleeve:

Upward and Downward:	within 5′ or 0.025mm	on the 15X	eyepiece	reticle (graduated by 0.1mm)
Inward:	within 10′ or 0.05mm	〃	〃	〃
Outward:	within 3′ or 0.015mm	〃	〃	〃

2) **Adjusting:**

i) **Repair** the eyepiece sleeve bending that might be caused by an accident during transportation or operation.

The bending is to be checked by deviation of the crosshair in the eyepiece which is observed by revolving the erecting prism housing like as adjusting the interpupillary distance.

ii) When the deviation is a little over the standard and there is no dent on the eyepiece sleeve, apply a piece of tin foil under the eyepiece sleeve holder (24) and or the prism seat (25). The adjustment of 0.03mm on the prism seat will effect a deviation about 5′ on the crosshair.

1–4. Adjusting the revolving axis and the optical axis of the erecting prism

1) Setting the tool

i) Place the trinoculars tube combined with the inclining prism tool (J25114) on the parallel stereo tool with the special collimator (J25116).

(For the microscopes manufactured by the production order No. 3 and thereafter, the round dovetail mount is provided with holes for adjusting the inclining prism)

ii) Removing the erecting prism boxes (3)(right) and (4)(left), place the erecting prism tool (J25115) on the trinoculars tube (Fig. 19).

iii) Shift the prism seat (25) (right) and (26) (left) outward (to the erecting prism tool side) as far as it goes slightly releasing the screws (101c).

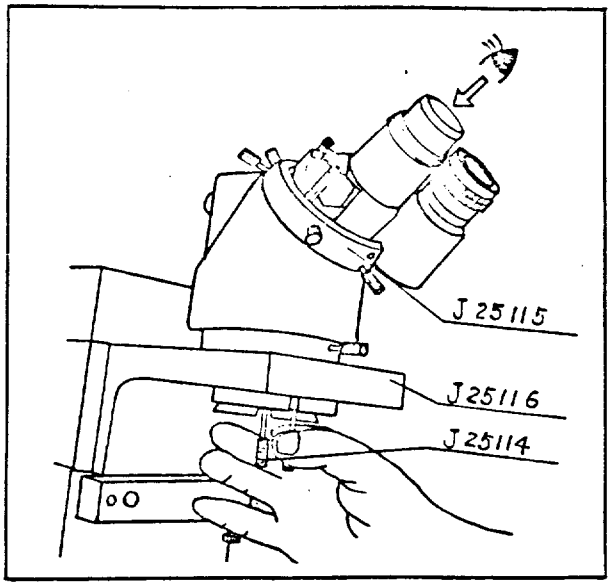

Fig. 19

2) Adjusting the revolving axis of the erecting prism

i) Put the non eccentric eyepiece into the sleeve which is to be adjusted upward or downward to focus the reticle of the special collimator of the tool (J25116).

ii) Bring the collimator reticle image to the position where it does not move by revolving the prism box base (5)(right) and (6)(left) following the procedure hereunder.

< How to position the revolving center of the erecting prism >

Observing over the viewfield find out the position where the collimator reticle image does not move when the prism box base is revolved as shown in Fig. 20.

This point is referred to as the revolving center of the erecting prism.

Adjust the prism seats (25) (right) and (26) (left) so as the collimator reticle image O_1 comes to the revolving center O_2 by means of the erecting prism tool (J25115) as shown in Fig. 21 ($O_1O_2 = \ell_1$).

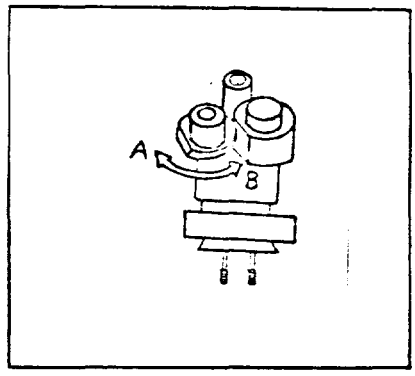

Fig. 20

< Pre-adjustment of the optical axis >

Then adjust the prism seat (25) (right) and (26) (left) to bring the collimator reticle center at O_2 up to the viewfield center O_0, by pushing the prism seat by the tool (J25115). (Fig. 22)

Refer to 4) (P.18) and 6) (P.21) for adjusting the optical axis.

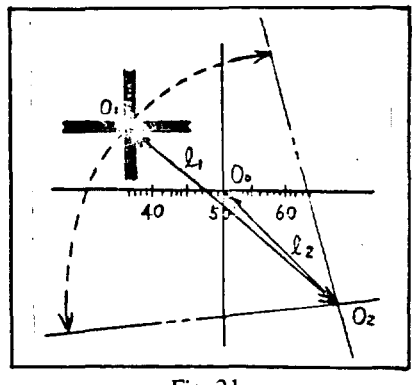

Fig. 21

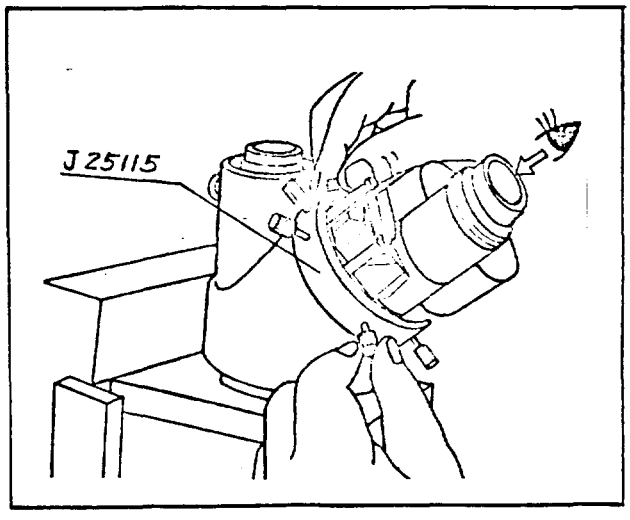

Fig. 22

3) Fixing the prism boxes (3-2) and (4-2)

Place the prism boxes on the prism box base (5-2), (6-2) avoiding to touch the prism or the prism seats.

4) Pre-adjustment of the optical axis

After adjusting the revolving center, the right and left optical axes are to be pre-adjusted. Use the parallel stereoscopic microscope tool collimator as its optical center has been adjusted in reference to its crosshair center.

If a tool that has not been adjusted as above is in use, revolve the trinoculars tube 180° to locate the revolving center which is found as a point at the middle of the crosshair center. displacement caused by this 180° revolution and is used as the reference point for optical axis adjustment.

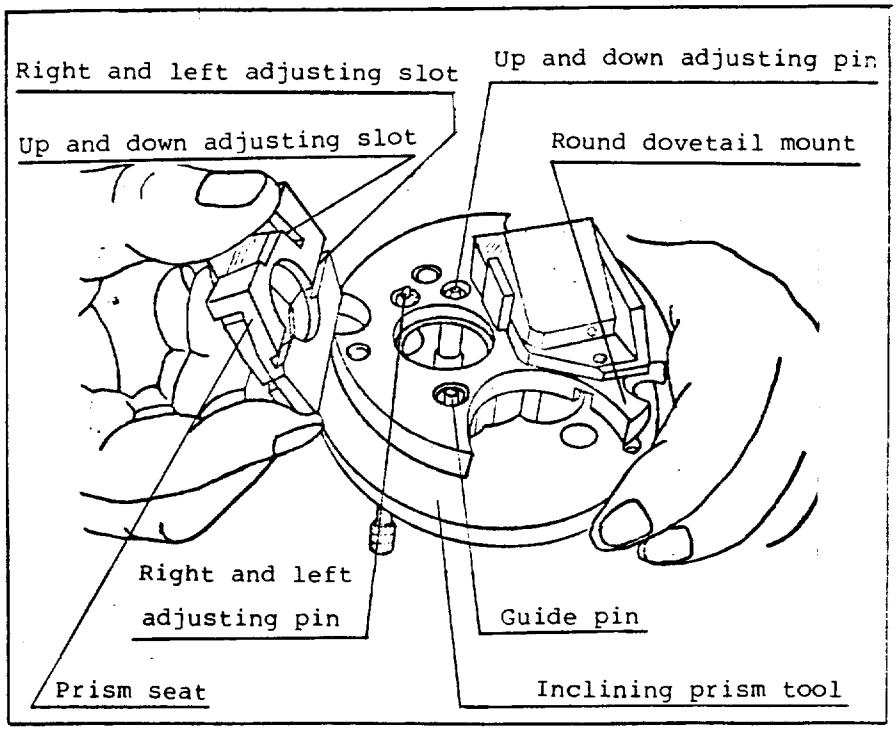

Fig. 23

- When the adjusting pin revolves, the prism seat is shifted by the eccentric pin point which couples with the slot under the prism seat, thus the optical axis is adjusted in right and left or back and forth.

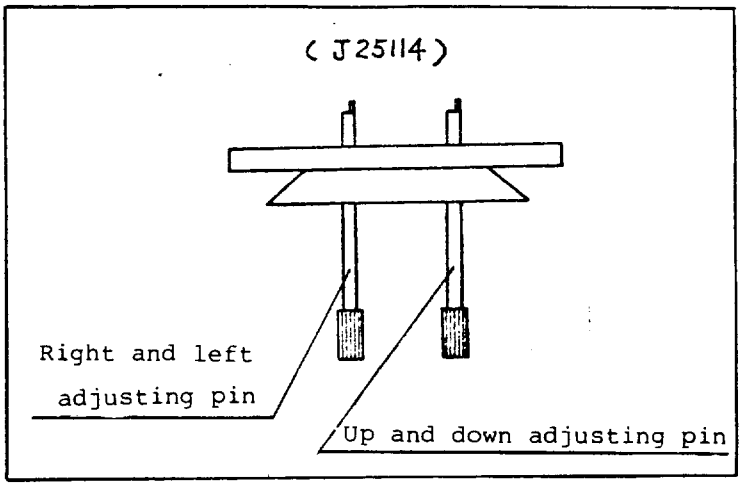

Fig. 24

[Function of the erecting prism tool]

In order to adjust evenness of right and left eyepiece diopter the pre-adjustment of the optical axis is to be made according to the following standard, then screw in the screws (101c)x4 to temporarily fix the prism seats (21-1) and (22-1).

Standard
- Right and left: Within 3' (0.14mm)
- Up and down: Within 1' (0.05mm)

Remarks: (F) When the optical axis is adjusted up or down the diopter may goes beyond the standard.

5) **Adjusting** the diopter ring in reference to the focusing (Fig. 25 ~ 28).

i) **Position** correctly the index tube (29) (so as the index directs to middle of shoulder of the prism box (3-1), (4-1) (Fig. 25).

ii) Put the 10.6mm parfocal eyepiece into the eyepiece sleeve (28) which is drawn out by 6mm out of the eyepiece sleeve holder (24) making the origin to read the diopter. Then focus the tool collimator reticle by using the diopter telescope as follows;

iii) If the reading of the diopter telescope is of plus value, adjust the secondary objective lens cell (19) in drawing out direction from the lens cell holder (7-1) of the zooming tube, and if it is of minus value in pushing in direction.

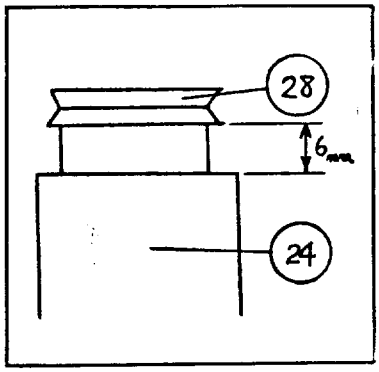

Fig. 25

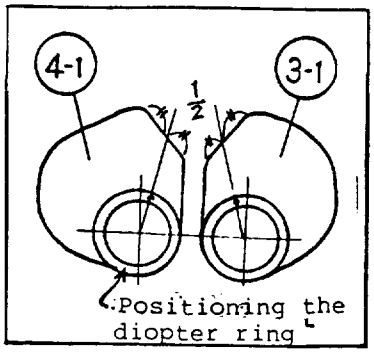

Fig. 26

iv) After finishing the diopter adjustment screwlock (19) to (7-1).

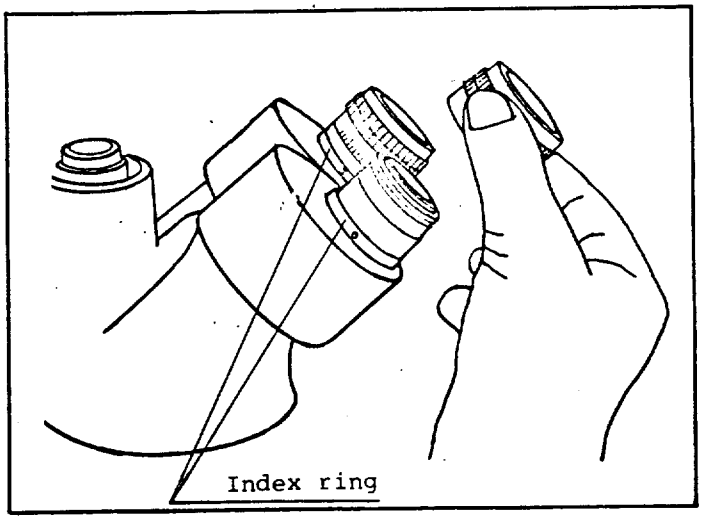

Fig. 27

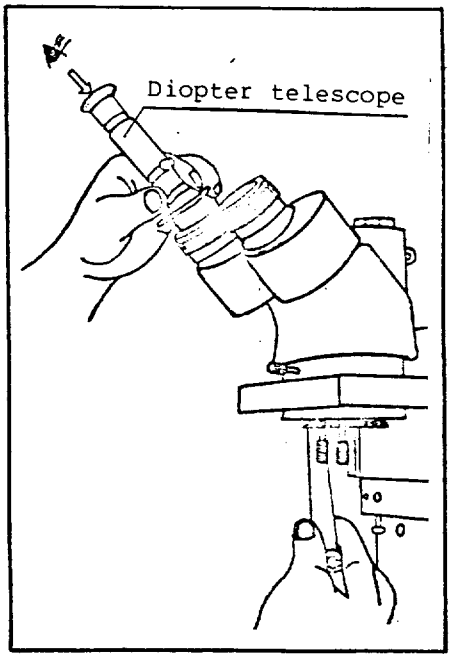

Fig. 28

6) Adjusting the optical axis

i) Standard of optical axis parallelism (with eyepiece of which minimum scale is 0.1)

Inward: Within 50'..... (or 2.5 divisions of the eyepiece reticle)

Outward: 0'..... (or 0 " ")

Upward and downward: Within 15'..... (0.75 " ")

Inclination of the image: Within 15' (by parallel collimators).

ii) When the screwlock on the (7-1) lens cell holder and (19) lens cell is dried and hardened, proceed to adjust the optical axis as follows:

Adjust first the right side optical axis as shown in Fig. 29 which indicates the relation between the collimator scale and the eyepiece crosshair.

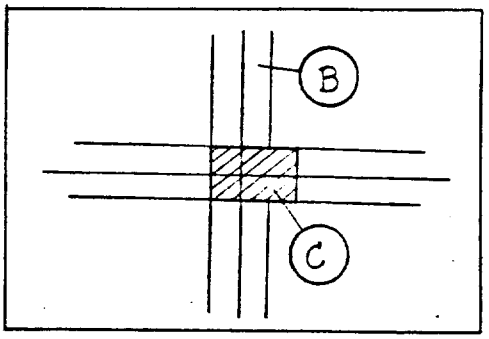

Fig. 29

(B) : Image of the collimator reticle (J25116) (Width of the reticle line is equal to 2 ~ 4 divisions of the eyepiece reticle.)

(C) : Adjust the right side optical axis so as the crosshair center of the right eyepiece reticle comes into the hatched area.

Remarks: (P). (F) The hatched area in Fig. 29 indicates the maximum allowance for the optical axis parallelism (0.2 X 0.3).

If the right axis is adjusted nearer to the center, easier is the left axis adjustment.

iii) Finishing the right optical axis, screw in the screws (101c)$_{\times 2}$ to fix the prism seat firmly.

iv) As the outward allowance for the optical axis adjustment is O, the left optical axis is to be adjusted so as the left eyepiece crosshair center comes inward in comparison with the right optical axis.

(Namely, the collimator reticle image shall be seen right side of the crosshair center of the left eyepiece)

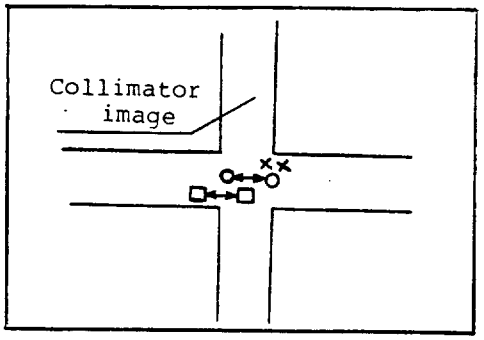

Fig. 30

(Position of collimator reticle image relative to crosshair in left eyepiece)

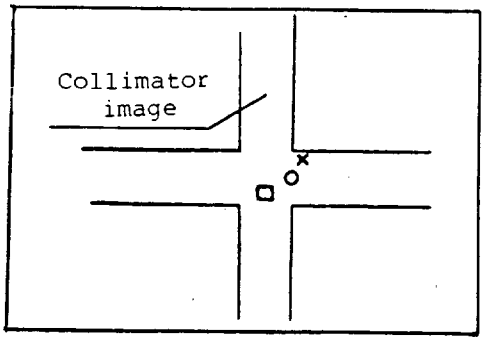

Fig. 31

(Position of collimator reticle image relative to crosshair in right eyepiece)

For example if the position of the eyepiece reticle center relative to the collimator reticle center in the right eyepiece is such that as shown by □ or ○ or × in Fig. 31, the left optical axis must be adjusted so as the left eyepiece reticle center comes within □ ↔ □ or ○ ↔ ○ or × ↔ × as shown in Fig. 30.

v) After the left side adjustment, tighten the screws to fix the prism seat and check the optical axis.

Remarks: (P) When it is difficult to assure of the optical axis parallelism because of slack in revolution axis, use the parallel collimators instead of the stereo tool collimator.

7) Checking and adjusting the perpendicularity

< Parpendicularity >

The flat contact planes of trinoculars round dovetail mount and that of the zooming tube are to be perpendicular to the optical axis.

For the conventional stereoscopic microscope, the perpendicular axis meant the revolving axis, however, for the parallel optical axis system, the perpendicularity is defined as above because the trinoculars tube are made separable from the zooming tube body.

Further, as the perpendicularity is also related to the parallelism of the right and left optical axes, if the former found deranged the latter is also to be checked.

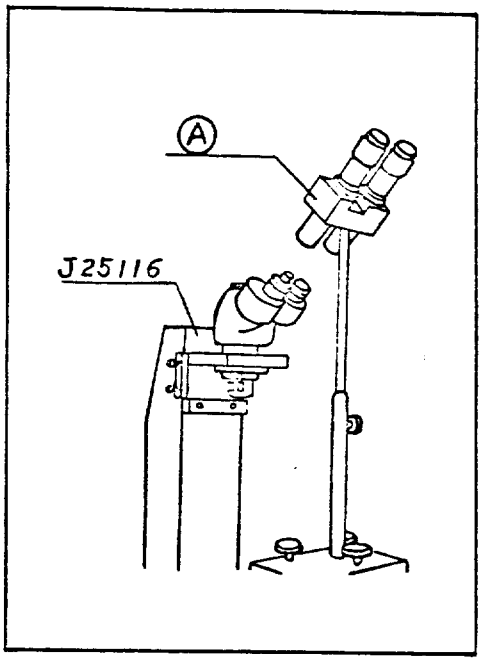

Fig. 32

i) Checking the perpendicularity

Place the trinoculars tube on the parallel stereo tool (J25116) as shown in Fig. 32. Then, revolve the trinoculars tube as illustrated in Fig. 33 and read the deviation of the collimator reticle center:

Standard for the center deviation: Within 3' (or within 2.8 divisions on the 10X eyepiece scale)

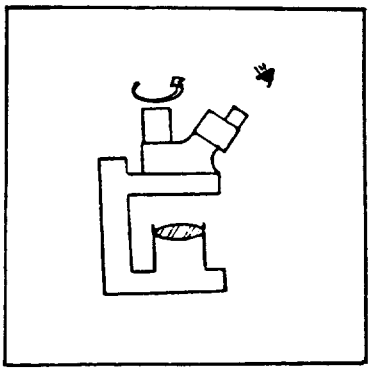

Fig. 33

ii) Adjusting the perpendicularity

Proceed the method of adjusting the optical axes parallelism.

1–5. Adjusting the photographic straight tube (except the binoculars tube)

< Pre-adjusting the optical axis and the focus >

With the photographic straight tube, the CF photoeyepiece (CFP) that is different from the observation eyepiece in diameter is used. Accordingly, for adjusting the photographic tube the Kellner reticle 10X eyepiece is to be used.

1) Place the trinoculars tube on the parallel stereo tool (J25116) and put the Kellner eyepiece into the photoeyepiece sleeve (11).
2) Pre-parfocal adjusting: Bring the collimator scale into focus by the eye observation revolving the photo-eyepiece sleeve (11).
3) Pre-adjusting the optical axis: Releasing the screws (101d)x3, move the eyepiece sleeve receptacle (10) and the sleeve (11) to bring the collimator scale center to the Kellner eyepiece scale center. (When the collimator center comes within 2 ~ 3 divisions of the Kellner scale, fasten temporarily the screws (101d)x3.)

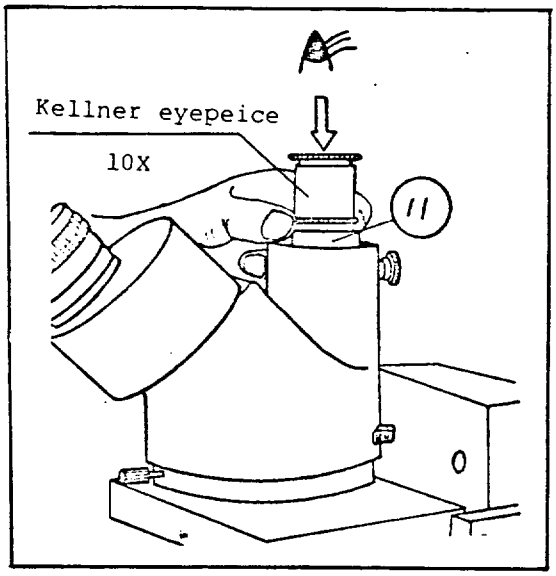

Fig. 34

< Assuring the optical path change over lever function >

1) **Changing** over the optical path from the right axis to the left axis, read the collimator **center deviation** in the Kellner eyepiece.
(The allowance for this deviation is within 3 divisions of the scale).
2) If the deviation is over 3 divisions, proceed as follows:
i) Check whether the mirror (G7) is relieved or not off the photographic lens holder (2)
ii) Check the mirror (G10) the same as above.
iii) If the mirror positioning is found all right in the above checking, the deviation seems to be caused because A and B surfaces of (2) are not in parallel (Fig. 35).

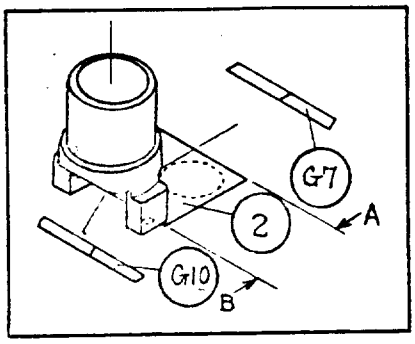

Fig. 35

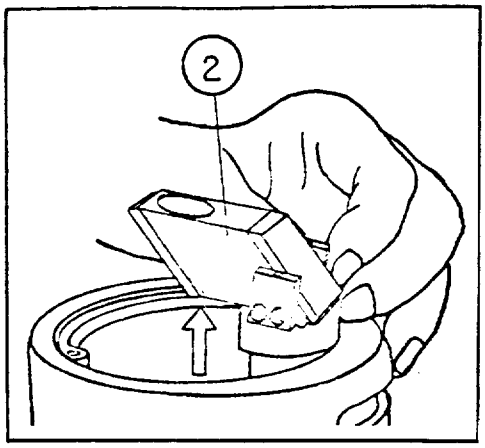

Fig. 36

< Adjusting the parfocal path change over and the optical axis >

1) Place the diopter telescope on the Kellner eyepiece and focus the Kellner eyepiece reticle on the telescope eyepiece reticle.
   Then revolve the photo eyepiece sleeve (11) to focus the collimator reticle (Fig. 37).
2) Changing over the optical path by the lever, check that the focus remains the same, then fix (10), (11) firmly with adhesive screwlock.
3) Assuring that screwlock on (10), (11) is dried up, release the screws (101d)x3 and move (10) to bring the Kellner reticle into coincidence with the collimator reticle.
   Confirming that the reticle deviation including the deviation due to the optical path change over is within 3 divisions of the reticle, fix the screws (101d)x3 by screwlock (Fig. 38).

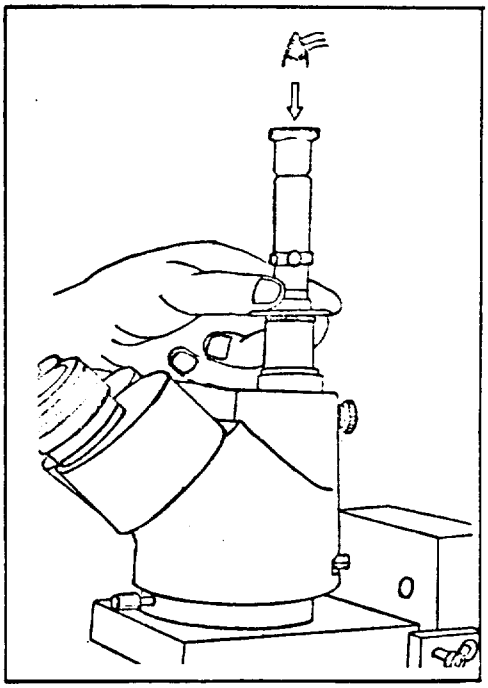

Fig. 37

Finally, remove the inclining prism tool and fix the round dovetail mount, then finish the repair of the trinoculars tube by checking internal dust and soil.

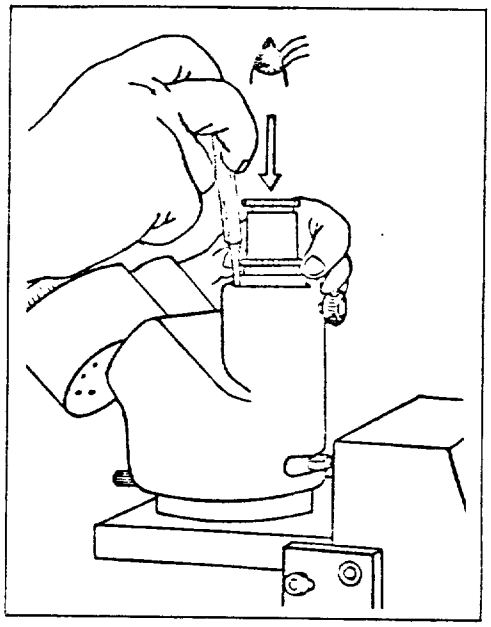

Fig. 38

2. Zooming Tube Body

2–1. Disassembling (Refer to remark 1), Page 30)

1) Unscrewing the screws (93a)x3, remove the lens cell (38) with the lenses (G1, 2)~(G3, 4) (Fig. 39)

2) Releasing the set screws (96a), remove the cover (39-1) (Fig. 40).

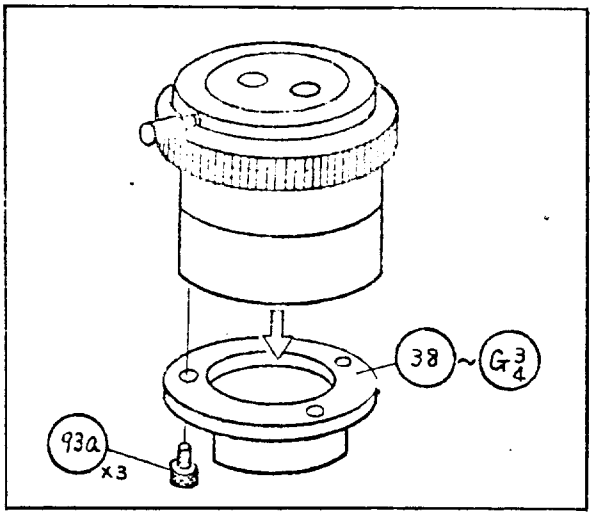

Fig. 39

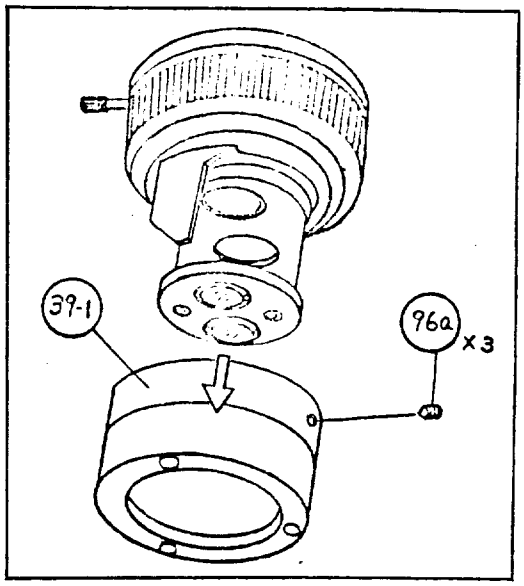

Fig. 40

Remarks: (P) If it is hard to remove (39-1) drop some machine oil into screw holes of (96a).

3) Peel off the knurled rubber ring (8) using a screwdriver or the like caring not to break it (Fig. 41).

4) Unscrewing the screws (91c)x2, remove the blind plate (4) (Fig. 42).

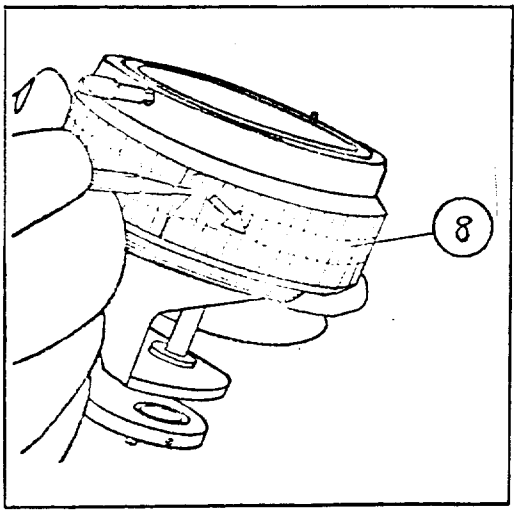

Fig. 41

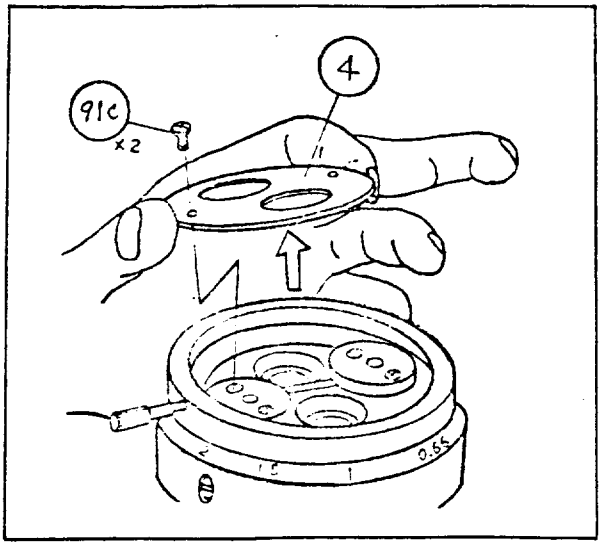

Fig. 42

5) Unscrewing the screws (93a)×2, remove the bottom plate (11) (Fig. 43).

6) Removing the spring hook (23), take out the lens carrier (17) (Fig. 44).

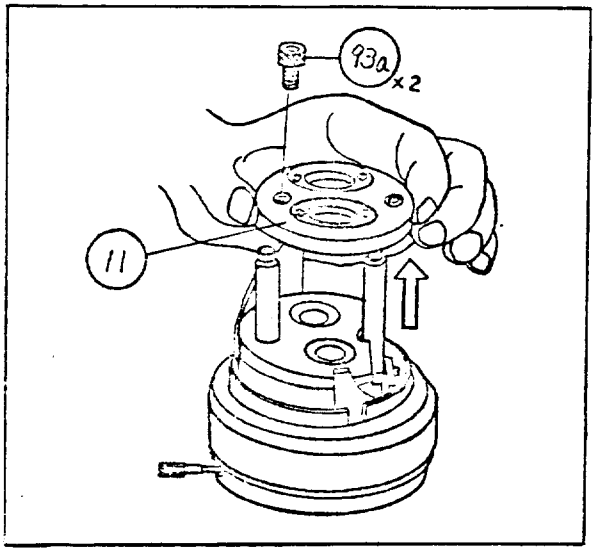

Fig. 43

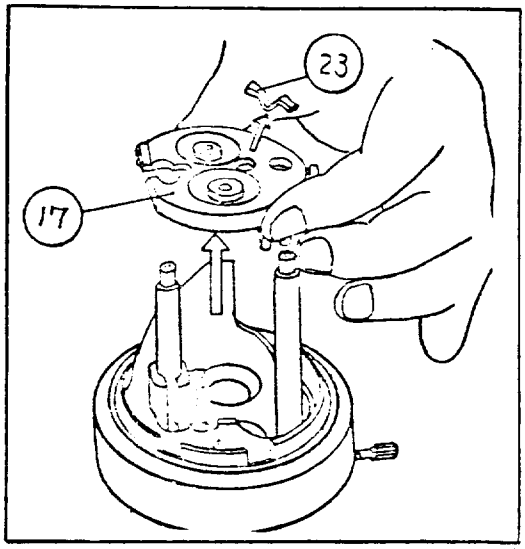

Fig. 44

7) Remove the spring (27) from the hook (25) using the special tool (Spring hooker (D)) (Fig. 45).

8) Take out the lens carrier (16) (Fig. 46).

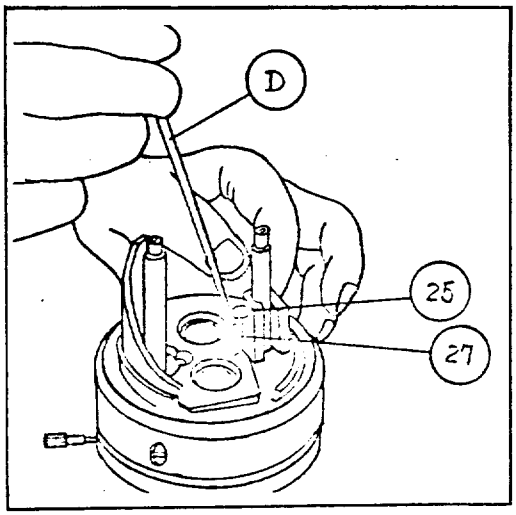

Fig. 45

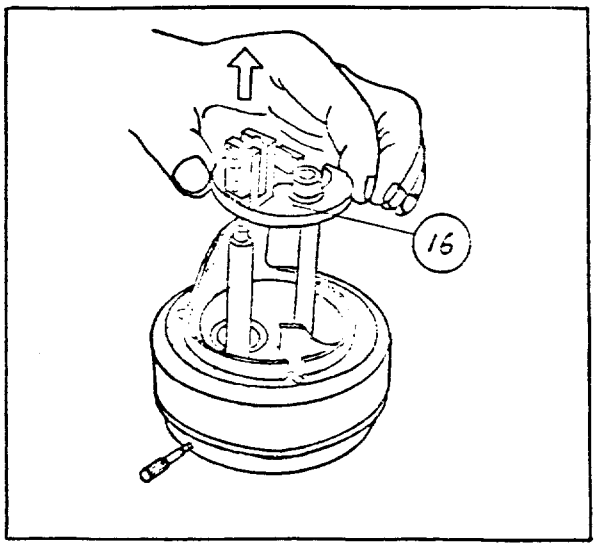

Fig. 46

9) Unscrewing the screws (93a)x3 remove the zooming ring retainer (14-1) (Fig. 47).

10) Remove the connecting pin (6) from the zooming ring (5) (Fig. 48).

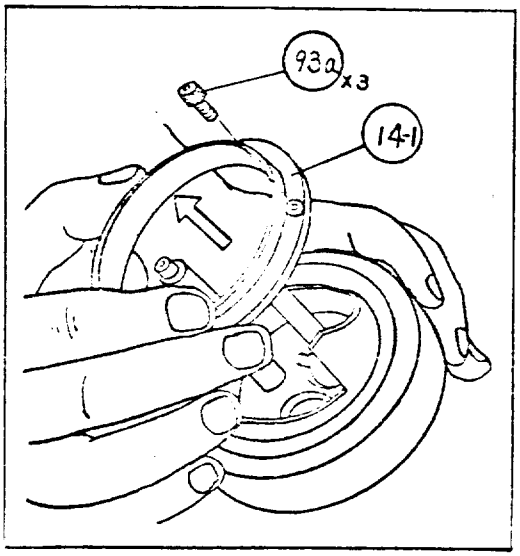

Fig. 47

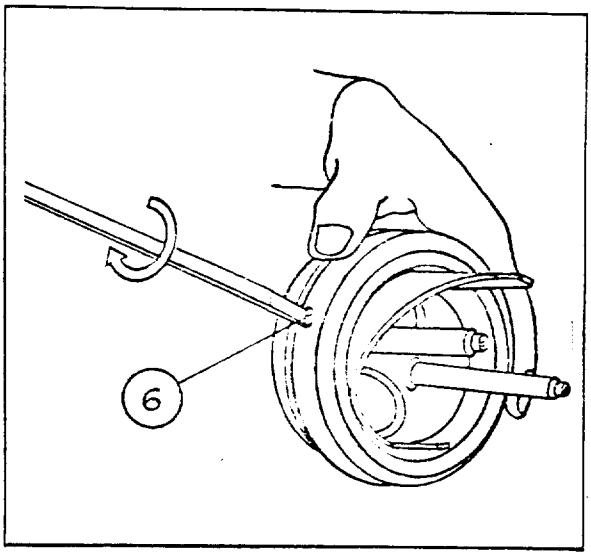

Fig. 48

11) Take out the zooming cam (15) (Fig. 49).

12) Unscrewing the set screw (95a), draw out the celluloid plate (7-1) and the plate spring (40) (Fig. 50).

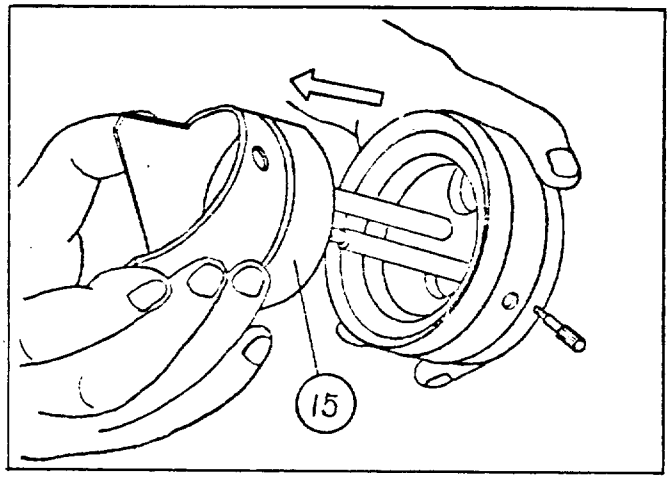

Fig. 49

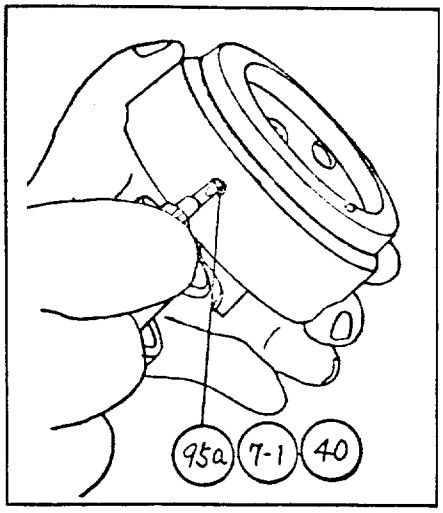

Fig. 50

13) Remove the zooming ring (5) (Fig. 51).

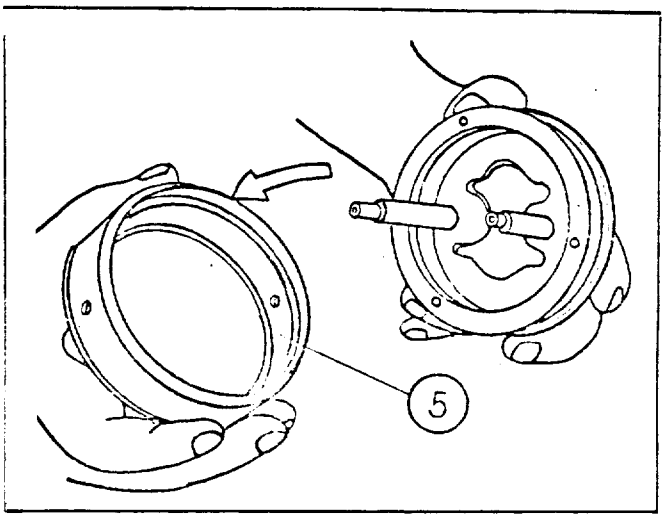

Fig. 51

2–2. Assembling

Proceed the assembling by reversing the disassembling procedure as 13) – 1), provided that the adjusting procedure is to be referred to.

Zooming tube

Adjustment after the overhaul

In order to maintain the interchangeability of the zooming tube for the trinoculars tube, the adjustment of the zooming tube herein explained is concerned about the procedure independent from the trinoculars tube using the special tool (J25116) (including the straight tube tool for observation) instead of the procedure for adjusting the zooming tube combined with the trinoculars tube.

< Performance of the optical elements >

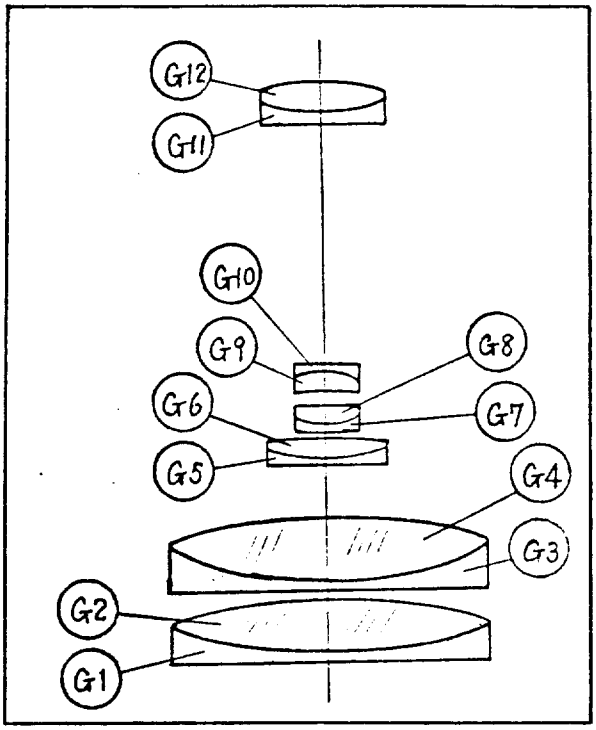

Fig. 52

((G11), (G12)) :

The low magnification (0.66X) focus is adjusted by revolving the lens cell A (28), and the low magnification optical axis is adjusted by shifting the lens cell holder (34). (Fitting of (28) – (34) and (33) – (34) are individually adjusted)

((G5) ~ (G10)) :

The high magnification (4X) focus is adjusted by revolving the lens cell (33-1), and the high magnification optical axis is adjusted by shifting the lens cell holder (34) (the screws (91b)x4 are to be released).

((G1) ~ (G4)) :

Moved away for the above repair and adjustment while the collimator lens of the parallel stereo tool is in use.

2–3. Pre-adjustment of parfocal zooming

1) Special tools

- Tool J25116 including the straight tube.
- Measuring eyepiece for parfocal zooming J25117:
  The focus displacement in zooming is read by the diopter scale of the 15X eyepiece.
- Diopter telescope

2) Adjusting

i) Place the observation straight tube on the parallel stereo tool (J25116) as shown in Fig. 53.
Remarks: (P) (F) Handle the tool gently because dent or deformation etc. on the mount would cause derangement of the optical axis and perpendicularity.

ii) Mount the zooming tube on the tool J25116 as shown in Fig. 53 (Remove the primary objective G1 ~4).

iii) Slide the straight tube to the right side up to be stopped.

iv) Revolving the zooming ring, set the magnification at 4X.

v) Adjusting the high magnification focus (4X).

a) Set the diopter scale at 0 on the tool 15X eyepiece.
Remarks: (P), (F) Set the diopter scale at 0 notwithstanding the observer's eyesight. If necessary use the diopter telescope.

b) Focus the collimator reticle image moving the G5, 6 back and forth by revolving the lens cell (33-1). When the focus is in plus side, screw out the lens cell (33-1) and if it is minus side, screw in the same.

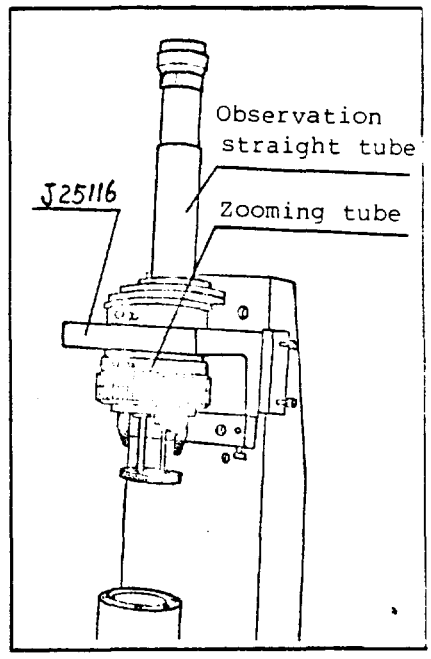

Fig. 53

vi) Adjusting the low magnification focus (0.66X)

a) Set the zooming ring at 0.66X (Fig. 54).

b) If the collimator reticle images goes out of focus, bring it into focus by revolving the eyepiece diopter scale.

This diopter deviation is to be corrected as follows:

- When the 0.66X focus is in plus side, screw out the lens cell (28) with G11, 12 and when it is in minus side screw in the same.

(180° revolution of (28) is equivalent to about 1mm width of the eyepiece diopter scale).

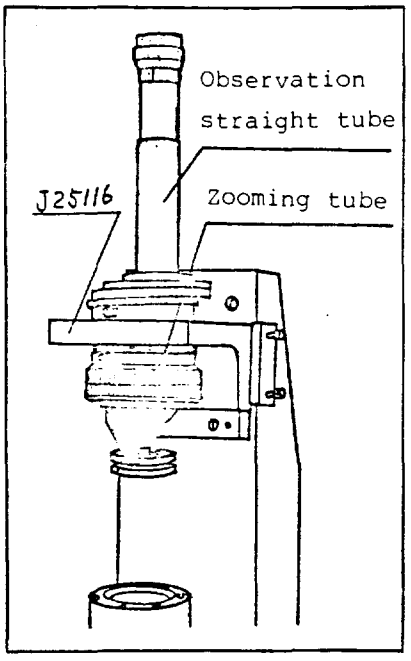

Fig. 54

vii) Pre-parfocal adjustment

As the 0.66X focus adjustment has an effect on the 4X focusing a little, it is necessary to repeat the procedure iv), v), vi) to finish the parfocal adjustment.

viii) Parfocal adjustment of the left side zooming

After adjusting the right side zooming as aforementioned, slide the straight tube to the left side up to be stopped and proceed the same procedure for the left side zooming.

2–4. Pre-adjustment of image deviation in course of zooming

As each of the right and left zooming is to be adjusted individually, slide the straight tube to right and left on the parallel stereo tool up to be stopped on each of the optical axis that is to be adjusted.

1) Adjusting the high magnification optical axis (4X)

i) Set the zooming ring at 4X.

ii) Adjust the lens cell (33-1) of G5, 6 to bring the collimator crosshair center into coincidence with the eyepiece reticle center and fasten temporarily the screws (91b) (Fig. 55).
(The collimator reticle image moves in the direction the same as the lens is moved.)

iii) If it is difficult to bring the collimator reticle image to the eyepiece reticle center exactly, leave it near the center (because the residual may be cancelled in the course of adjusting the low magnification optical axis).

iv) The fine adjustment is possible by means of the screw (94a) x4.

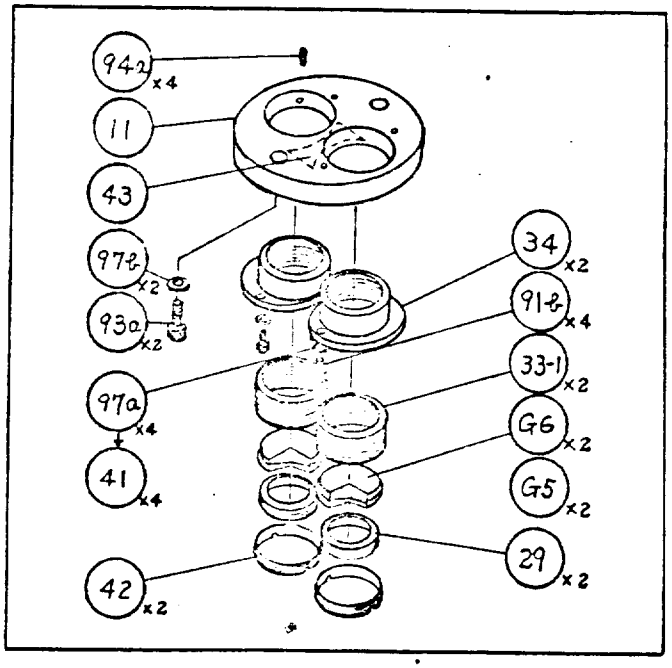

Fig. 55

2) Adjusting the low magnification optical axis (0.66X)

i) Set the zooming ring at 0.66X.

ii) If the optical axis is not duly positioned, the collimator reticle image moves in the eyepiece view field when the magnification is changed from 4X to 0.66X (Image deviation).
The deviated collimator reticle image is to be brought back to the center by adjusting the lens cell (34) of G11, 12 (Fig. 56).

iii) The collimator image moves in the direction the same as the lens moving direction.

iv) The fine adjustment is possible by means of the screws (94a) x4 if necessary.

Remarks: (P), (F) Support the lens carrier (16) at its bottom by your finger for fastening the screws (91b) x4.

3) By repeating the procedure 1) ~ 2) the optical axis is brought to the position where no image deviation occurs in zooming.
The image deviation is to be adjusted to come within 3 divisions (0.3mm) on the eyepiece reticle scale for each of the right and the left optical axis.

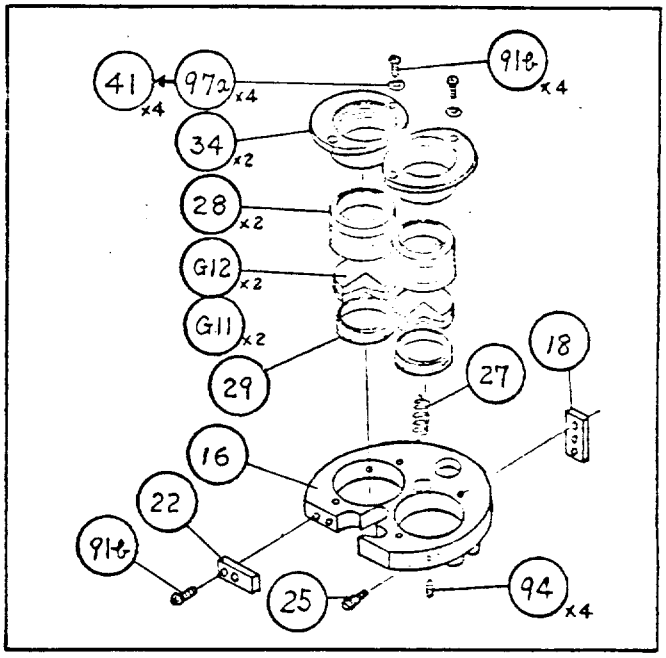

Fig. 56

2–5. Parfocal zooming and diopter adjustment (Fig. 57)

1) Diopter adjustment for the high magnification (4X).

i) Set the zooming ring at 4X.

ii) Set the tool 15X eyepiece diopter scale at 0.

iii) Bring the collimator reticle to focus on the 15X eyepiece reticle following the procedure 2–3, Pre-parfocal adjusting.

iv) As the image side depth of focus at high magnification is deep, it would be necessary to watch the change of the image colour to adjust the lens cell (33-1) of G5, 6 back and forth.

v) Read the difference of the 15X eyepiece diopter scale reading between the focusing on each of the right and left optical axis by placing the straight tube over each axis.
Adjust the cell (33-1) until the difference (referred to as diopter difference) between the right and left readings comes within 1 divisions of the eyepiece diopter scale.

2) Parfocal adjustment for the low magnification (Fig. 56)

i) Set the zooming ring at 0.66X.

ii) Adjust the focus by moving the lens cell (28) of G11, 12 back and forth for each of the right and left optical axes until the diopter difference between the both comes within 2 divisions on the eyepiece diopter scale.

3) Checking the parfocal zooming at intermediate magnification (Fig. 56, 57).
Even if the parfocal zooming have been obtained for the magnification 4X and 0.66X, it is not yet assured of the intermediate magnification because of:
Inaccurate positioning of the bearing (20) relative to the zooming cam which the movement of zooming lenses depend on.
In such a case as above, position the bearings by adjusting the bearing holder (18) and the bearing shaft (19).

Remarks 1 : (P), (F) The bearing axes are to be positioned perpendicular to the line of zooming movement and in the directions that make 180° each other.
(18) is not to be unnecessarily moved.

Remarks 2 : (P) In measuring the parfocal zooming, put the 15X eyepiece with crosshair and scale into the straight tube of the special tool J25116, which is to be used together with the diopter telescope.

Standard

4X	3X	2X	1X	0.66X
1.15mm	0.74mm	0.48mm	0.36mm	0.36mm

Standard

for measurement: Via 15X eyepiece scale, 1 div. for 0.28mm.

for observation: Via trinoculars 10X eyepiece, 1 div. for 0.67mm.

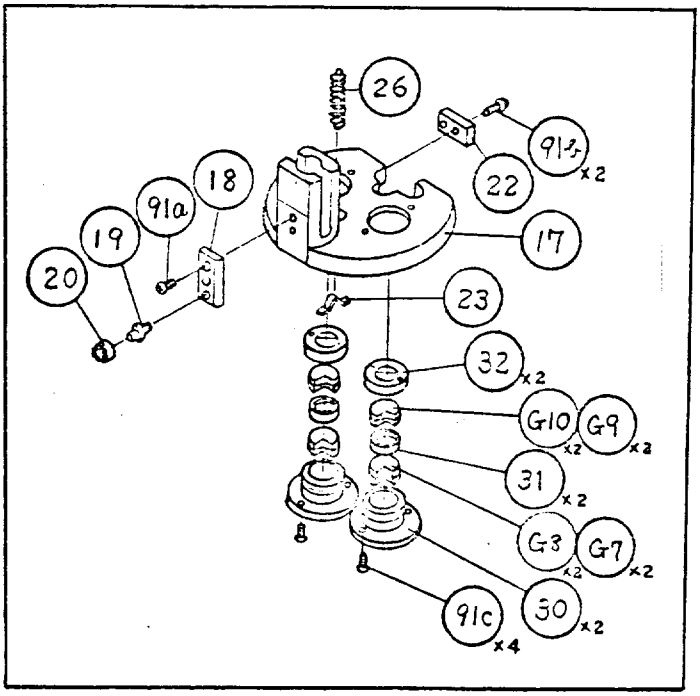

Fig. 57

4) Confirming the diopter difference

In reference to the aforementioned standard, the error in parfocal zooming is allowed in plus and minus sides for each of the right and left zooming axis, accordingly the maximum difference in the right and left focus position may possibly becomes 2 times as large as the standard.

(For example, the maximum difference at 4X will be 1.15 X 2 = 2.3mm)

Therefore, it is recommended to adjust the zooming, allowing the error in the same direction for each axis in consideration of the mechanical backlash.

(For example if the error is assumed +1.15 for the both axes the difference between right and left will become 1.15 – 1.15 = 0).

Finishing the adjustment of the parfocal zooming and of the diopter difference, fix the following parts with screwlock:

The lens cell of G5, 6 ..... (33-1)x2 and (34)x2.

" " G11, 12 ..... (28) x2 and (34)x2.

2–6. Adjusting perpendicularity, parallelism of optical axes and image deviation.

1) Adjusting the perpendicularity, of the optical axes

i) Put the 15X eyepiece into the straight tube which is to be slide to the right side up to be stopped.

ii) Set the zooming ring at 4X.

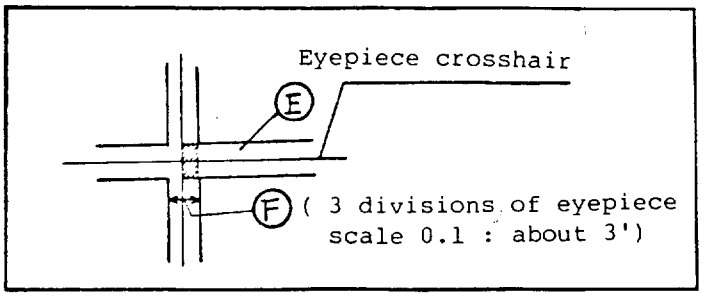

Fig. 58

iii) Bring the collimator reticle image center within the hatched area (Fig. 58) on the eyepiece reticle by adjusting the lens cells (34)$_{x2}$ of G5, 6.

Release slightly the screws (91b)$_{x2}$ as the screws (94a)$_{x2}$ are to be used for fine adjustment.

The collimator reticle image moves in the direction same as the (94a) moves.

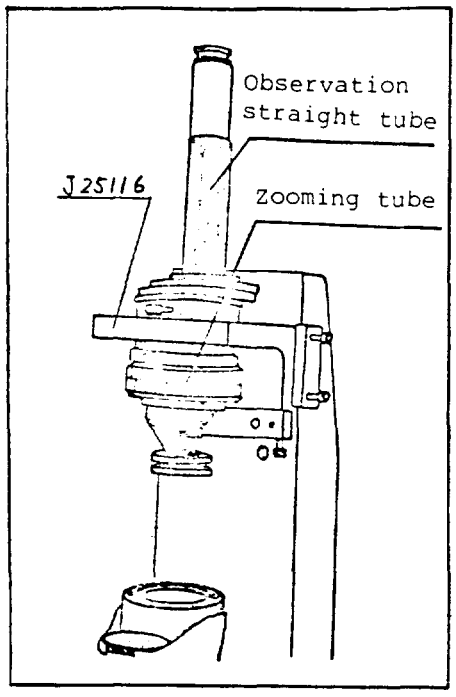

Fig. 59

Remarks 1): (P) The allowance for the perpendicularity is 3′ (0.14mm).
However, in consideration of the parallelism with the left optical axis which is to be adjusted outward relative to the right axis as shown in Fig. 60, the range of allowance for the right optical axis is restricted as shown in Fig. 58.

(Since the special tool for the straight tube is without erecting system, outward adjustment using special tool with straight tube are equivalent to inward when the zooming tube is combined with the trinocular tube.)

Remarks 2): (P) As the tool collimator has been adjusted so that the reticle center is in coincidence with the optical center, it is unnecessary to rotate the zooming tube body 180° to check the perpendicularity. However, when another tool is in use, the zooming tube must be rotated 180° to check the perpendicularity.

2) Adjusting the image displacement

i) Set the zooming ring at 0.66X.

ii) Adjust the lens cell holders (34)$_{x2}$ of G11, 12 by means of the adjusting screws (94a)$_{x4}$ as explained in 2–4, Pre-adjustment.

iii) As the collimator reticle image is too small at the magnification 0.66X to read the scale, read the deviation by the eyepiece reticle scale.

The allowance for the adjustment is 0.5 division outward on the eyepiece reticle.

Remarks: (F) Screwing (94a) without releasing (91b) will impair the zooming function.

3) The optical axis perpendicularity and image deviation

Repeat the procedures 1)~2) to finish the adjustment obtaining the accuracy within the allowance and screw in (91b)x4 firmly.

4) Adjusting the right and left optical axes in parallel and adjusting the left side image deviation.

i) Place the straight tube on the left optical axis and set the zooming ring at 4X.

ii) Assuming that the right optical axis is exactly perpendicular, the left optical axis is to be adjusted as illustrated in Fig. 60, 61.

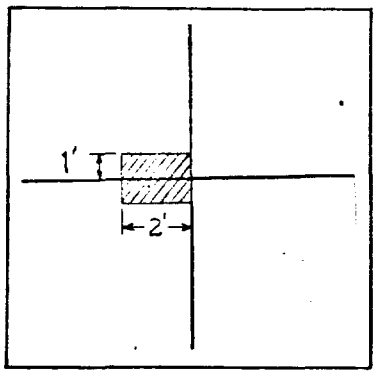

Fig. 60

(Position collimator reticle image relative to crosshair in left eyepiece.)

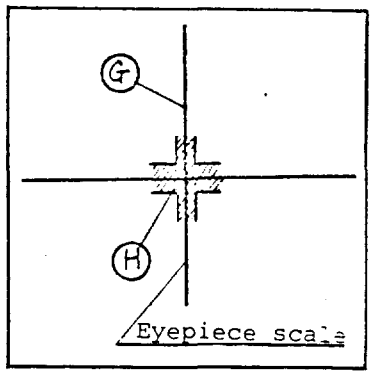

Fig. 61

(Position collimator reticle image relative to crosshair in right eyepiece.)

Namely, the left optical axis is to be adjusted to come into the hatched area (positioning the lens cell (33-1) by the fine adjusting screw (94a) to bring the collimator reticle center into the hatched area in the eyepiece viewfield).

Standard of the parallelism allowance:

For the left optical axis:

Upward and downward	1' (0.05mm)	taking right optical axis as standard.
Outward	2' (0.1mm)	difference between right and left.
Inward	0	

Remarks 1): The reason for inward and outward adjustment of the optical axis:

The allowances abovementioned are to be applicable to the adjustment using the special tool with the straight tube, and are equivalent to outward 0′, inward 2′ when the zooming tube is combined with the trinocular tube.

Axes of human eyes are parallel when looking at a distant object and adjust themselves inward when looking at a near object.

When the sighting lines of both eyes make an angle of 2′ inward, the eyes will feel fatigue the least.

As the eyes can not afford the outward angled sighting, the outward tolerance for the optical axes parallelism is not allowed.

Remarks 2): (P) The reason why the parallelism of the zooming tube body is adjusted within 2′ outward:

The trinoculars tube has the erecting prisms to invert the image, while the straight tube of the special tool has no erecting prism, accordingly, the outward deflection of the axes in the measurement by the straight tube is equivalent to the inward deflection in the trinoculars tube.

5) Checking tightness of screwing and cementing

i) All of the screws used in adjusting should be fixed by screwlock.

ii) Fixing of the screws (91a) for ball bearing (19), (20) is especially important because the looseness of same may cause the focus impairment.

iii) To prevent the fine adjusting screws (94a)$_{\times 4}$ from loosening, plug the screw hole with KE24 silicon cement.

Screwlock or cemedine makes the repair impossible afterward.

6) Attaching the primary objective

i) Place the lens cell (38), (39-1) with G1, 2 and G3, 4 and fasten the screws (96a)x3 (HS3 × 0.5 × 3) firmly.

ii) Checking dust and soil on the optical parts and place the blind cover (4)

3. Focusing Mount

3–1. Disassembling

1) Driving up the rack (G1) to the top of the dovetail groove, remove the HS bolt (21C) (Fig. 62).

2) Sliding down the rack, draw it with dovetail and the clamp mount out from the dovetail groove (Fig. 63).

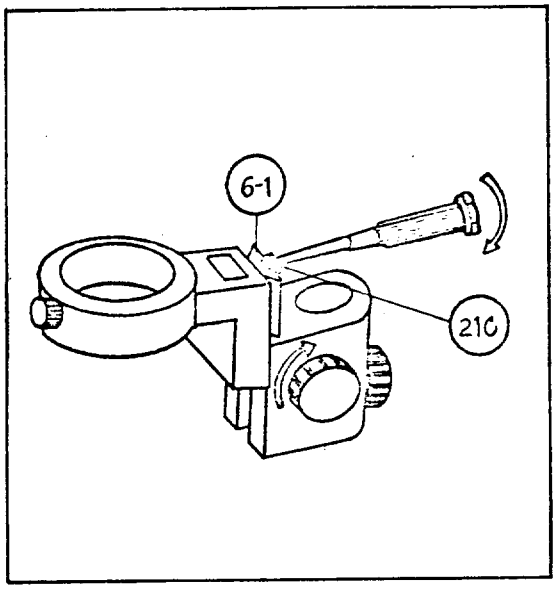

Fig. 62

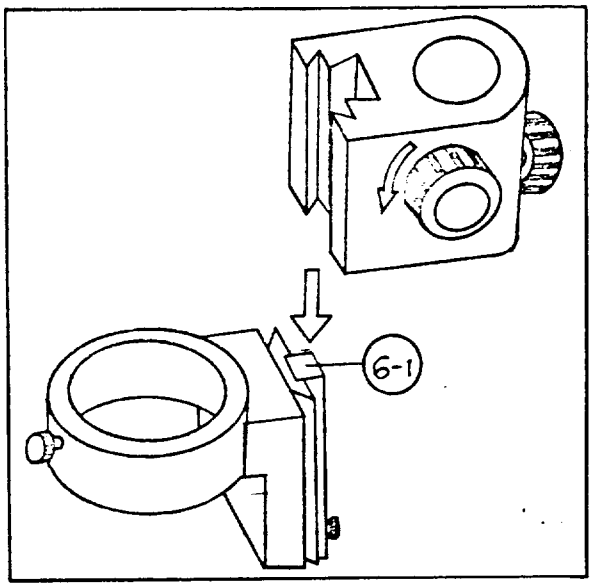

Fig. 63

3) Unscrewing the HS bolt (21C), remove the rack (6-1) (Fig. 64).

4) Unscrewing the HS bolts (21B)x2, remove the dovetail (5-1) (Fig. 65).

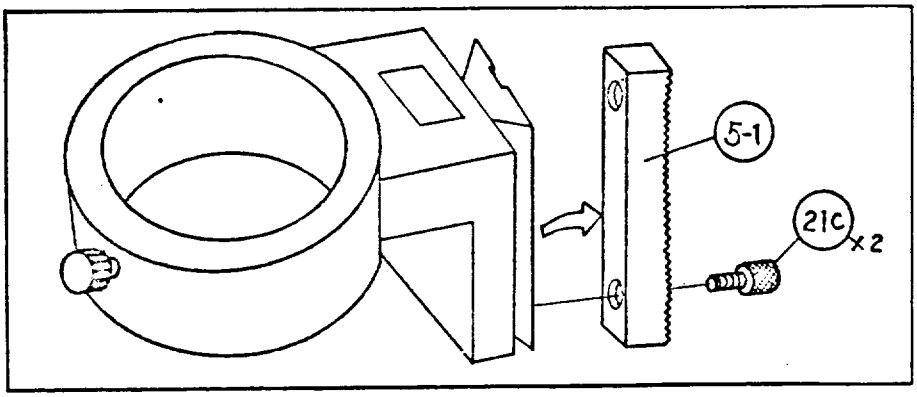

Fig. 64

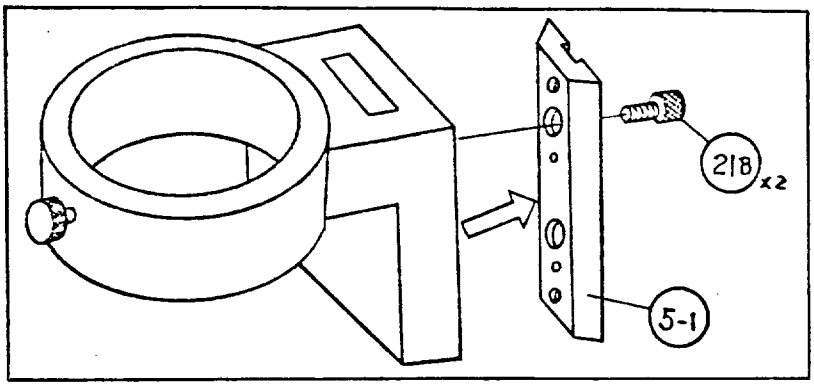

Fig. 65

5) Peel of the sticker (11-1) on the focusing knob tearing it by a screwdriver (Fig. 66).

Remarks: (P) The above operation is needed for one only of the 2 knobs as illustrated.

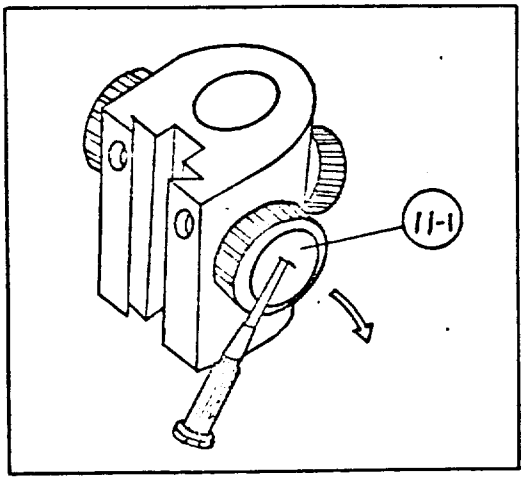

Fig. 66

6) Take off the focusing knob (8-1) with the friction chip (9-1) by unscrewing (Fig. 67).

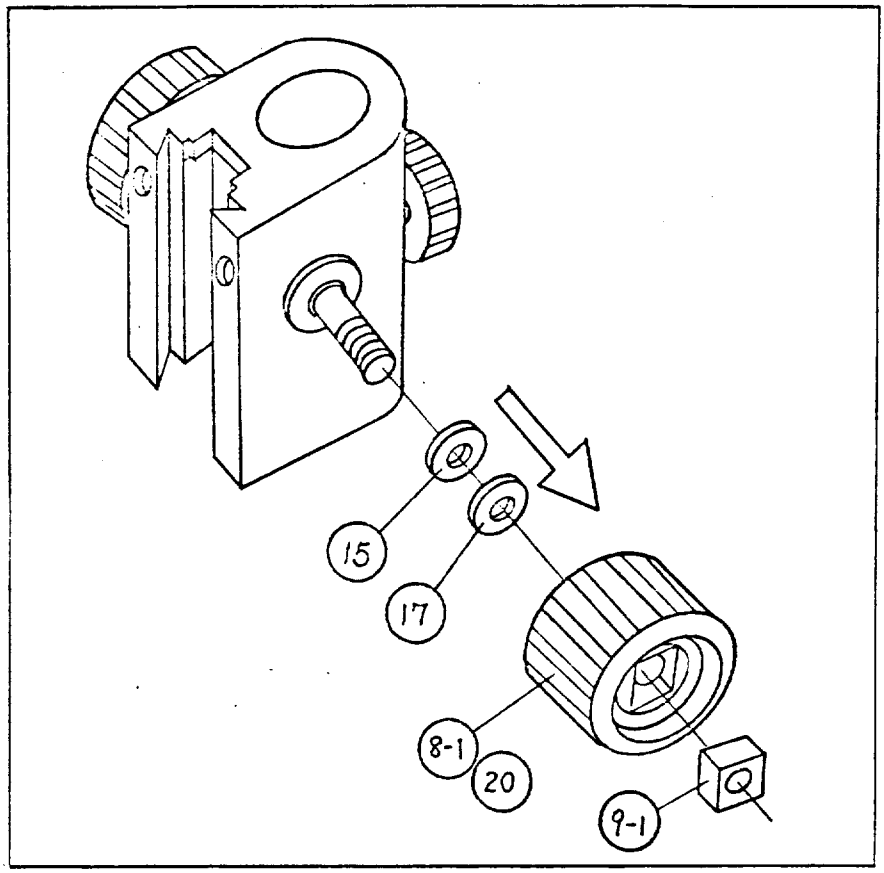

Fig. 67

7) Draw out the pinion shaft (4-1) togetherwith the focusing knob (7-1) (Fig. 68).

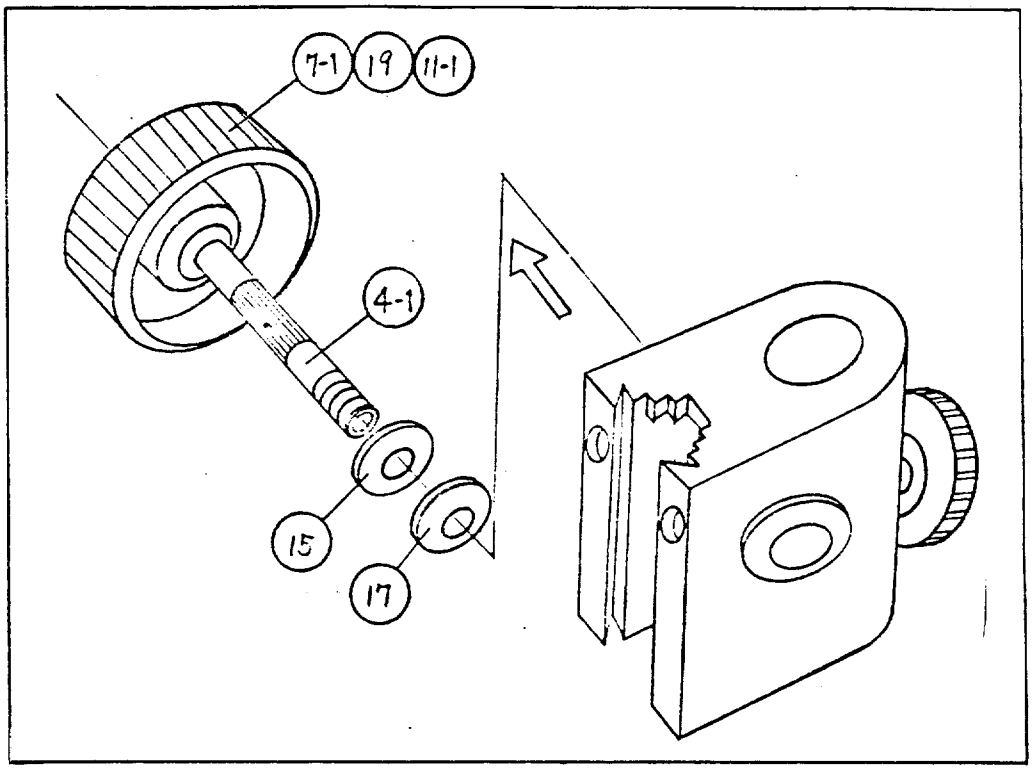

Fig. 68

8) Removing the HS bolts (21A)x2, draw out the pinion holder (3) (Fig. 69).

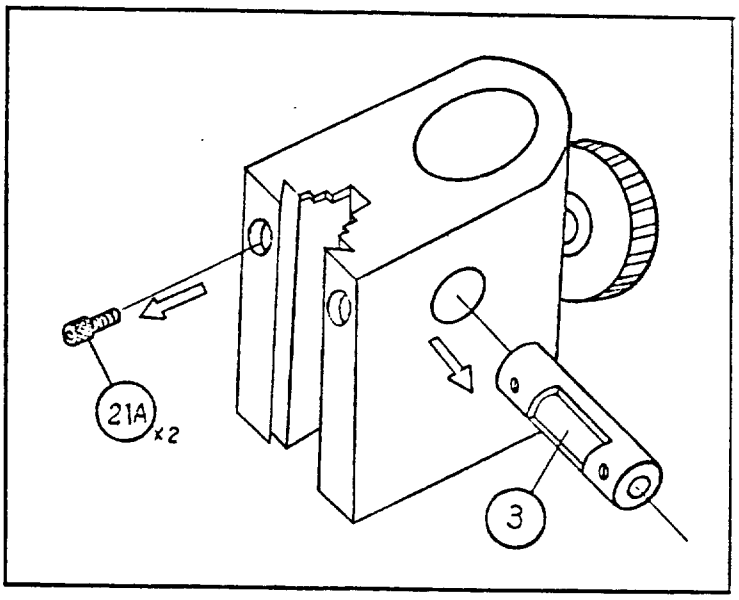

Fig. 69

3–2. Assembling

Reverse the disassembling procedure 1) ~ 8) of 3–1, with reference to the adjusting procedure.

INSPECTION AFTER REPAIR (Proceed in accordance with necessity)

1. The Zooming Tube Body

   1) The zooming operation and the torque required:

   Check the operating status by hand feeling. Make sure that the operation is smooth without sticking nor squeeezing.

   Measure the revolving torque by a spring balance and assure that it measures between 7000 ~ 1200 g-cm.

   2) The body tube clamp:

   Mount the zooming tube body and check the function of the clamp screw by hand feeling.

   3) Optical performance:

   Check the right and left optical axes parallelism, optical axis deviation by zooming, parfocal zooming, magnification error, magnification difference between right left optical system, etc. in reference with the procedures of Repair and adjustment.

   4) Image definition, etc.

   Combine the zooming tube body with the trinoculars tube or the binoculars tube and observe or photograph various specimen in reference to ghost or flare that may disturb the image definition.

2. The Trinoculars Tube and Binoculars Tube

   1) The clamp screw for photo equipment:

   (for the trinoculars tube only)

   Make sure of smooth and secure function of the clamping by hand feeling.

   2) The optical path change-over lever:

   (for the trinoculars tube only)

   Make sure of smooth operation and secure click stopping by hand feeling.

3) The eyepiece diopter ring and the interpupillary distance adjustment:

Make sure that the diopter ring functions smooth without sticking and unevenness.

Also assure that the interpupillary distance is adjustable for the range of 54mm ~ 74mm (±1) or more by measuring with the vernier calipers.

4) Range of the eyepiece diopter adjustment:

Focus the eyepiece at the secondary objective's focal point and measure with the vernier calipers the range of the eyepiece movement for diopter adjustment starting from that point to confirm that:

Diopter adjustment range	Eyepiece movement range
+6 ~ −8 Diopt	+3.75mm ~ −5mm or more

with the 10X eyepiece

5) Level difference between the right and left eyepieces:

Confirm that the right and left eyepieces are positioning on the same level or the level difference is less than 1mm by measuring with the stretch diopter adjusting ring.

6) Mechanical parallelism and optical axes parallelism of the inclined eyepiece tubes:

Deviation of the tool collimator reticle image in the viewfield of the eyepiece:

(error in the perpendicularity of the optical axis against the mounting plane)

Position of the secondary objective's focus:

Inclination of the right and left images:

Difference of magnification between the right and left optical systems:

Refer to the procedure of Repair and adjustment for all of the above.

7) Image definition etc.:

Combining the trinoculars tube or the binoculars tube with the zooming tube body and the 10X eyepiece or other eyepieces together, observe variety of specimens to assure of the image definition relative to ghost or flare that may disturb observation or photography.

3. Focusing Mount

1) Clamping the focusing mount on the stand pole:

Confirm that the clamping is secure without slack in screwing by hand feeling.

2) Clamping the zooming tube body on the mount:

Confirm that the clamping is secure without slack in screwing, and also the same about clamping the stopping ring by hand feeling.

3) Focusing knob:

Make sure that the movement is smooth for the whole range of focusing without unevenness nor squeezing by hand feeling and by loading 3 Kg weight.

Confirm that the focusing torque is adequate and not in excess nor in deficit.

GUIDE FOR USERS TO PREVENT THE INSTRUMENT FROM IMPAIRMENT

- Clean exterior surfaces (the objective, eyepieces) and exposed parts before and after using.
- Use the instrument at a place free from vibration, direct sunlight, dust, high temperature and moisture.
- For the lubrication, use the specified lubricant in conformity with the lubricant table.
- To maintain the proper performance, it is essential to handle the instrument keeping the optical parts from anything that may cause strain.
- For a long distance transportation, pack the instrument correctly in the case that can be locked or in the transporting case of foam-stylene.
- For storage, place the instrument covered with the accompanying vinyl cover in the case and keep it at a place free from moisture.

  Keeping the objectives and the eyepieces in a container with absorbent is recommended for preventing fungus growing.